SECTION 2 CIRCULAR ECONOMY: RECYCLING AND INNOVATIVE TECHNOLOGIES

"Building the circular economy requires innovative solutions that transform industries through new materials, energy and ingredients alongside new business models, designs, logistics and recovery solutions. ... Concerted action targeted at changing the way industries do business is needed to accelerate the circular transition."

Circular Trailblazers: Scale-Ups Leading the Way Towards a More Circular Economy. White Paper. World Economic Forum, January 2021

"The transition to a more efficient and circular use of raw materials in the automotive sector is far more than an environmental issue; it's the only way to meet the ever-increasing demand for mobility in the context of finite natural resources. Circular economy innovation has been continuously contributing to Renault's industrial competitiveness and increasing net profits for the past five years."

Jean-Philippe Hermine, Vice-President, Strategic Environmental Planning, Renault-Nissan Alliance, France. Driving the Sustainability of Production Systems with Fourth Industrial Revolution Innovation. January 2018

CIRCULAR ECONOMY: MEASURING THE MATERIAL FOOTPRINT

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Introduction. Today the circular economy is declared as one of a key pathway for sustainable development. In this direction, the EU has adopted the Circular Economy Action Plan for Europe, which will contribute to achieving the Sustainable Development Goals, especially SDG 12. The results of major reform measures should contribute to lowering natural resource inputs and minimizing waste, and finding crosscutting approaches that will make dramatic progress for a cleaner and more competitive Europe possible (EU CEAP, 2020). However, for Ukraine, the search for circular coherence in industry is a radically new strategy and that the significant efforts are required (Palekhov & Palekhova, 2020).

This article discusses the challenges and principles of transition to the circular economy for a reduction in the material footprint. Particular focus has been placed on examining the methodology for calculating the material footprint applied by the EU. Approaches to assessing the material footprint of the metallurgical value chain in Ukraine are proposed.

Presentation of the main research. As is known, the circular economy is an alternative to a traditional linear economy (viz. make, use, and dispose). Under a new production and consumption model, we keep resources in use for as long as possible, extract the maximum value from them whilst in use, then recover and regenerate products and materials at the end of each service life (WRAP, 2021). In this way, the circular economy creates extended opportunities for economic growth and sustainable development.

As emphasized in the literature, there is no single approach or model of how to carry out the circular economy analysis. Nevertheless, the thematic evaluations cover usually the following fields: (1) material footprint; (2) fossil-fuel and energy consumption; (3) industrial and household waste; (4) environmental aspects and greenhouse gas emissions. Reducing the material footprint can be considered one of the most difficult and outstanding issue.

In the light of the European policy on “accelerating circularity in the context of the single market,… the sharing and collaborative economy, ... less dependence on primary materials” (EU CEAP, 2020), countries must strive to reduce the consumption of existing natural resources. The centrally planned economies of the European Union are increasingly open to market circular forces, and a tremendous readjustment is occurring in all industries, which reduces the consumption of primary commodities.

Yet, the situation is much more complex and nuanced. As the global sustainability reports indicate, the higher is the contribution of an economy to the regional and global GDP, the higher is its material footprint, since the production and final consumption in those countries linked on material resources from other countries through international supply chains. A sharp contrast in material footprint can be seen between the strongest economies (e.g. Denmark, Netherlands Sweden, and Germany, France, United Kingdom).

At the same time, a low material footprint characterizes all weak economies (e.g. Bulgaria, Serbia, and Ukraine), although they take different part in global value chains as raw material suppliers (Palekhov & Palekhova, 2020).

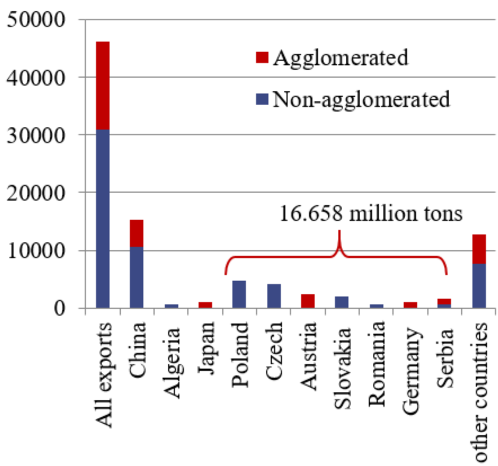
In particular, according to World Mining Data 2020, Ukraine ranks 7th in the world for iron ore mining. In 2020, the total volume of iron ore production amounted to 163.30 million tons, of which 28.3 per cent were exported (see Figure 1). As we can see, more than one third of iron ore exports account for the Top 7 importer countries from EU, thereby Ukraine directly increases their material footprint.

Some methodologies already exist that can help directly or indirectly measure the effectiveness of practical implementation of the circular economy (e.g. Eurostat’s Handbook for estimating raw material equivalents). As defined by the General Commission for Sustainable Development, material footprint quantifies the demand for material extractions triggered by consumption and investment by businesses, households and governments (GCSD, 2018).

It should be noted that there are some methods and procedures for estimating the material footprint, depending on the type of country, resources, economic sector, etc.

Figure 1

Impact of export of Ukrainian metallurgical products on the material footprint of European economies, 2020 (compiled from Ukrstat, 2021)



Top-7 EU countries-partners in Ukrainian export of iron ore and concentrates

Poland	10,0%
Czech	8,8%
Austria	5,3%
Slovakia	4,9%
Serbia	3,6%
Germany	2,4%
Romania	1,5%
	36%

Eurostat on an EU-wide level uses an input-output method based on input-output tables from national accounts and Material Flow Accounts (MFA), and today efforts are being made to apply this metric internationally. For that purpose, Eurostat has developed the Handbook as the methodological tool for country-level estimates of product flows in raw material equivalents (RME) (Eurostat, 2021a). In addition to this, Eurostat publishes annual results on Raw Material Equivalent (RME) of product flows at EU-28 level.

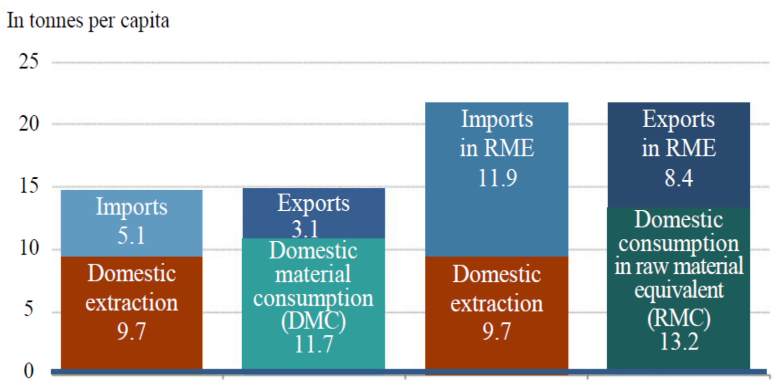
According to the Handbook, resources are divided into enlarged groups: biomass, metal ores, non-metallic minerals and fossil energy materials/carriers. The measuring indicators are the following: (1) Domestic Material Consumption (DMC); (2) Raw Material Equivalents (RME); (3) Raw Material Consumption (RMC) or 'Material Footprint'.

DMC (or 'apparent consumption') take into account the full range of raw materials actually being mobilized in order to satisfy domestic demand for goods and services from resident economic agents, but does take into account the tonnage of materials extracted domestically (to which imports are added and exports subtracted). Raw Material Consumption (RMC), otherwise referred to as the 'Material Footprint', is Domestic consumption expressed in 'Raw Material Equivalent' (RME).

For calculating RMC, the total imports and exports (tonnages registered in customs statistics) are measured in terms of RME. This results in an increased trade balance, i.e. the consumption level, when expressed as RME (the real material footprint or RMC) is higher than the weight of apparent consumption (DMC). Based on this methodology, the data in the Figure 2 shows that in France the actual consumption of raw materials (RMC, 873 Mt or 13.2 t/cap) is higher than the weight of apparent consumption (DMC, 777 Mt or 11.7 t/cap). It is thus estimated that, by the Eurostat, EU imports in 2019 were 2.0 times higher, and exports were 3.1 times higher when expressed in RME than recorded in EW-MFA.

Figure 2

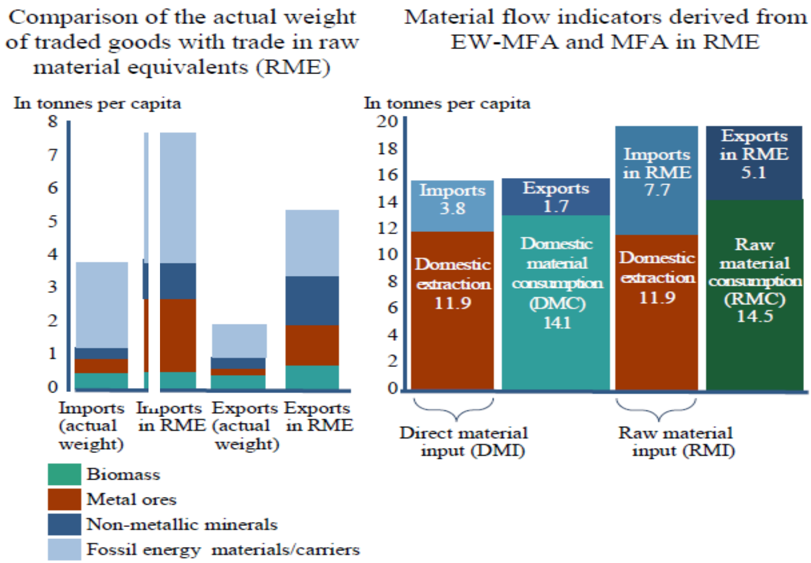
Material Footprint of France, apparent and in terms of Raw Material Equivalent, 2014 (GCSD, 2018)



The derived global material footprint (RMC) was 14.5 tonnes per capita in the EU in 2019 and 2.9 per cent higher than DMC (see Figure 3).

Figure 3

EU's Material Footprint, 2019 (compiled from Eurostat, 2021b)



Conclusions. The circular economy can make a significant contribution to the sustainability through transitioning to reducing the national material footprint. Research confirms the following facts:

- Export flows of raw materials directly and indirectly affect the real material footprint of importing countries.
- Quantifying the differences between the indicators Domestic Material Consumption (or "apparent consumption") and Raw Material Consumption (or "real consumption") shows that these indicators do not match. The European economy generally have a RMC larger than DMC, whereas the reverse is observed for net exporters.
- Countries with stable or declining DMCs may actually have a growing material footprint.

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