

Aspects of the Circular Economy in the Member States of the European Union

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Abstract

The interest in having a low-carbon economy has led to transformations in the economies of all countries. New economic models are being put into practice. New jobs are being created. Sustainable use of resources is becoming more important. The article presents an analysis of waste generation in the member countries of the European Union. The study of the possibility of reusing certain materials started from the design phase of the finished product. Production processes can also contribute to saving natural resources. This can create new business opportunities and avoid inefficient waste management. The article also analyzes the degree of municipal waste collection, as well as the share of recycled municipal waste. In the production process, the recovery of certain materials and then their use can lead to savings in the use of raw materials. This reduces the pressure exerted by the extraction of raw materials on the environment. Further investments in green technologies will contribute to the efficient use of natural resources, restore biodiversity and reduce pollution.

Keywords: generation of waste, recycling of waste, European Union

1. Introduction

Reducing the impact of waste on the environment is one of the desideratum of this century (Bran et al., 2020). Savings can have sustainable growth based on increasing resource efficiency (Radulescu et al., 2021). This is one of the ways in which waste generated can be reduced in general. Resource efficiency can also lead to reduced greenhouse gas emissions. Environmental degradation is caused by global warming and climate change (Radulescu et al., 2020). The circular economy contributes to the efficiency of waste management (Bodislaw et al., 2019). Thus, the reuse in the production process of certain categories of waste can lead to a decrease in the impact they have on the environment (Negescu Oancea, et al., 2020).

It is estimated that by 2050 the amount of waste will increase to 3,4 billion tons (billion tons). Of this amount, approximately 44% will be food/green, 17% paper/cardboard, 12% plastic, 5% glass, and 4% metal. Also, the Europe and Central Asia area will generate 392 million tons annually (WB, 2018).

It is hoped that economic growth will not be based on increasing resource consumption (Jianu et al., 2019). It is also desired that the products made by enterprises become more and more sustainable (EC, 2020).

The need to achieve sustainable products and services can lead to the emergence of new business models (Sarbu et al., 2021). Based on upgrading knowledge and skills, these new

models can lead to the creation of new jobs (Burlacu et al., 2019). The sustainability of such models aims to avoid waste generation (Angheluta et al., 2019). The use of secondary raw materials in the production flow can lead to a reduction in the amount of final waste (Profiroiu et al., 2020). Responsible consumption and production cannot be addressed without taking into account the issues related to the circular economy (Profiroiu et al., 2020).

One of the important aspects of sustainable development is the physical flows of energy and materials. Thus, in terms of volume and size, there is a decrease in the global natural ecosystem. Earth-sustaining functions can no longer be provided by terrestrial ecosystems due to their declining qualitative potential (Korhonen et al., 2018a).

2. Literature Review

Over time, the concept of circular economy has been used in various forms of sustainability, such as: Ecodesign, Closed-Loop-Supply Chain Management, eco-efficiency and Cleaner Production, industrial Ecology (Reike et al., 2018). The way in which the problems related to waste and waste were approached led to the idea of circularity.

The idea of circular economy is found in different types of organizations and in various fields of activity. It is important that the transformation from a wasteful and linear structure into a reproductive, restorative and cyclical structure leads, in the short and long term, to a more sustainable global society (Korhonen et al., 2018b). The concept of circular economy has had different interpretations. Thus, it can be considered as an economic system that refers to a recovery, recycling, reuse of materials in all phases of production, distribution and consumption (Kirchherr et al., 2017).

At the level of the European Union there is a certain interest in the circular economy. Thus, the circular economy package provides for concrete actions that envisage a complete cycle, from production to consumption. Issues related to the waste generated as well as to the raw materials used are also mentioned (EEA, 2016).

The consumption of primary resources could be more efficient by applying the concept of circular economy. Consumption of primary raw materials could be reduced by reusing waste from the production of a product. This waste can thus be considered as secondary raw materials. Such an approach would create new job opportunities.

Natural and material resources are components of a continuous flow that underpin the economies of European Union countries. The volatility of natural resources, as well as their rising price, can put pressure on economies (EEA, 2016).

Only by considering all dimensions of the circular economy (economic, technical, environmental, social), waste can be capitalized as resources (Moraga et al., 2019).

New models of savings lead to changes in technological flows. These changes start right from the design stage. Issues related to the conservation of natural resources as well as the use of waste as secondary resources are also considered. In this way, given this last aspect, the new designed models could be based on secondary resources. Last but not least, the new savings models require changes in consumer behavior. It is found, however, that the link between the circular economy and consumption is increasingly relevant (Camacho-Otero et al., 2018).

The use of waste as a secondary raw material can have positive economic effects (OECD,

2013). Thus, measures are needed to implement standards regarding the ecological design of future products and to increase the efficiency of the materials used (Vanegas *et al.*, 2018). Increasing the efficiency of construction materials and reducing the waste generated by this sector can lead to an 80% reduction in greenhouse gas emissions (Hertwich *et al.*, 2020).

Another effect of waste recycling is the possibility of reducing greenhouse gas emissions. The transition to the circular economy cannot have uniform benefits. Some businesses or industries have something to lose and others to gain. Obtaining benefits is conditioned by the degree to which those appropriate skills are identified and applied, leading to the circular economy (EEA, 2016).

There are also some fears that the circular economy may not lead to those long-awaited environmental or economic gains. From this point of view, the transition to a sustainable circular economy must take into account the biophysical limitations of circularity (Velenturf *et al.*, 2019).

However, it is considered that human society has the opportunity to find solutions for the waste streams produced to be integrated into nature's own cycles. Thus, waste could be used both for the benefit of the human economy and for the benefit of nature (Korhonen *et al.*, 2018a).

3. Methodology of Research

The article presents an analysis of waste generation in the member countries of the European Union. The article also analyzes the degree of municipal waste collection, as well as the share of recycled municipal waste.

4. Results and Discussions

It is considered that a harmonization of waste collection systems can lead to a decrease in the amount of municipal waste (EC, 2020).

The following table presents the comparative situation of the quantities of municipal waste generated per capita, for the member countries of the European Union, for the period 2008-2018 (kilograms per capita).

Table 1: Comparative situation of quantities of municipal waste generated per capita, 2008-2018

Countries	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
European Union	518	510	503	499	488	478	478	480	490	495	495
Belgium	480	467	456	455	445	436	425	412	419	411	409
Bulgaria	599	598	554	508	460	432	442	419	404	435	407
Czechia	306	317	318	320	308	307	310	316	339	489	494
Denmark	830	762	:	862	806	813	808	822	830	820	814
Germany	589	592	602	626	619	615	631	632	633	627	606
Estonia	392	339	305	301	280	293	357	359	376	390	405
Ireland	718	651	624	616	585	:	562	:	581	576	598
Greece	458	464	532	503	495	482	488	488	498	504	515
Spain	551	542	510	485	468	454	448	456	463	473	475

Countries	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
France	538	534	534	534	527	520	517	516	530	535	535
Croatia	415	405	379	384	391	404	387	393	403	416	432
Italy	552	543	547	529	504	491	488	486	497	488	501
Cyprus	729	729	695	676	664	618	602	620	633	625	646
Latvia	345	352	324	350	323	350	364	404	410	411	407
Lithuania	428	381	404	442	445	433	433	448	444	455	464
Luxembourg	697	679	679	666	652	616	626	607	815	798	803
Hungary	454	430	403	382	402	378	385	377	379	385	381
Malta	674	649	601	589	590	579	591	640	641	666	663
Netherlands	600	589	571	568	549	526	527	523	520	513	511
Austria	600	590	562	573	579	578	565	560	564	570	579
Poland	320	316	316	319	317	297	272	286	307	307	315
Portugal	518	520	516	490	453	440	453	460	474	486	507
Romania	411	381	313	259	251	254	249	247	261	272	272
Slovenia	542	524	490	415	362	414	432	449	457	471	486
Slovakia	313	307	319	311	306	304	320	329	348	378	414
Finland	521	480	470	505	506	493	482	500	504	510	551
Sweden	485	472	441	453	454	455	443	451	447	452	434

Source: processing according to data published by EUROSTAT, 2021

From the data presented in the table, it is observed that in 2018, compared to 2008, the amount of municipal waste generated in kilograms per capita increased in: Czechia (+188 kilograms per capita), Luxembourg (+106 kilograms per capita), Slovenia (+101 kilograms per capita), Latvia (+62 kilograms per capita), Greece (+57 kilograms per capita). Also, for the same period, the amount of municipal waste generated in kilograms per capita decreased in the following countries: Bulgaria (-192 kilograms per capita), Romania (-139 kilograms per capita), Ireland (-120 kilograms per capita), Netherlands (-89 kilograms per capita), Cyprus (-83 kilograms per capita). In 2018, the highest amounts of municipal waste generated in kilograms per capita were recorded in: Denmark (814 kilograms per capita), Luxembourg (803 kilograms per capita), Malta (663 kilograms per capita), Cyprus (646 kilograms per capita), Germany (606 kilograms per capita), Ireland (598 kilograms per capita), Austria (579 kilograms per capita). Also, the smallest quantities were generated in: Romania (272 kilograms per capita), Poland (315 kilograms per capita), Hungary (381 kilograms per capita), Estonia (405 kilograms per capita), Bulgaria (407 kilograms per capita), Latvia (407 kilograms per capita).

The following graph, for the period 2008-2018, shows the evolution of the amount of municipal waste generated in kilograms per capita in the European Union.

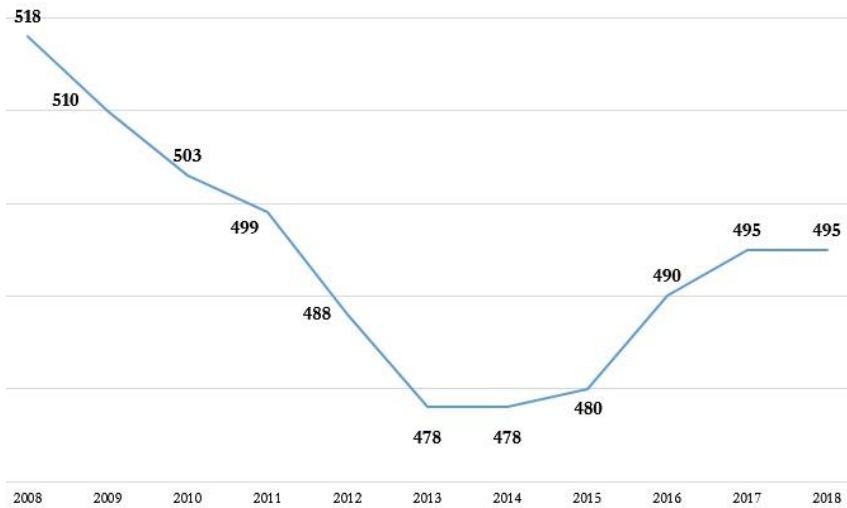


Figure 1: Evolution of the amount of municipal waste generated in kilograms per capita, 2008-2018
Source: processing according to data published by EUROSTAT, 2021

At European level, in 2018, compared to 2008, the amount of municipal waste generated in Kilograms per capita decreased by 23 kilograms (from 518 Kilograms per capita to 495 Kilograms per capita). It is observed that in the period 2008-2013 the values decreased, and in the following period, until 2018, the values increased.

The following table presents the comparative situation of generation of waste (excluding major mineral wastes per domestic material consumption), for the period 2004-2018 (%).

Table 2: Comparative situation of generation of waste (excluding major mineral wastes per domestic material consumption), 2004-2018, (%)

Countries	2004	2006	2008	2010	2012	2014	2016	2018
European Union	11,0	10,8	10,2	11,9	12,2	12,6	12,9	12,7
Belgium	20,9	20,8	14,8	25,0	20,5	23,1	25,4	26,4
Bulgaria	13,4	10,4	11,2	12,3	14,0	13,1	13,3	15,2
Czechia	9,3	6,7	6,4	7,4	8,0	7,3	7,8	9,7
Denmark	5,9	5,6	6,3	9,0	7,4	8,2	7,1	7,4
Germany	9,1	9,0	9,8	11,1	11,0	11,5	12,2	12,1
Estonia	49,9	36,1	31,2	34,5	31,8	33,6	33,3	29,7
Ireland	3,3	3,0	1,7	11,9	9,1	8,4	8,1	6,6
Greece	15,5	16,7	10,0	12,7	15,6	15,1	11,4	13,3
Spain	9,7	8,4	8,7	10,5	15,6	16,9	17,2	16,4
France	10,5	10,5	10,6	12,4	12,6	12,3	13,3	13,0
Croatia	8,6	8,1	4,8	6,9	6,5	7,9	8,4	8,8
Italy	10,1	10,5	11,8	14,5	17,2	21,4	22,5	22,9
Cyprus	10,5	4,9	2,6	3,7	4,0	5,4	5,4	5,2
Latvia	5,5	6,1	4,7	6,6	7,9	8,3	6,4	4,8
Lithuania	16,2	13,7	10,8	7,9	7,8	7,5	7,9	7,9
Luxembourg	10,2	10,7	10,0	14,0	11,9	7,6	11,4	10,0

Countries	2004	2006	2008	2010	2012	2014	2016	2018
Hungary	12,0	10,7	9,0	11,8	13,1	9,4	9,2	7,0
Malta	8,1	8,3	12,3	11,4	8,9	8,0	9,3	8,4
Netherlands	22,2	22,5	20,9	22,9	23,8	24,5	25,6	27,9
Austria	13,8	13,0	13,5	9,9	8,8	9,6	9,8	9,9
Poland	10,8	10,9	9,3	10,3	10,2	11,5	11,8	10,9
Portugal	9,7	11,6	6,0	5,7	6,7	7,3	7,7	8,1
Romania	13,2	13,6	10,3	8,6	6,5	5,6	4,7	4,8
Slovenia	11,2	9,2	8,1	11,6	13,6	12,2	11,4	10,3
Slovakia	10,2	13,1	10,5	9,2	10,5	9,3	11,8	11,7
Finland	12,4	12,9	11,1	13,1	11,8	8,1	8,2	7,4
Sweden	12,9	12,8	11,2	9,0	8,5	8,1	9,2	8,7

Source: processing according to data published by EUROSTAT, 2021

It is observed that in 2018, compared to 2004, the share of generation of waste (excluding major mineral wastes per domestic material consumption) increased in: Italy (+12,8%), Spain (+6,7%), Netherlands (+ 5,7%), Belgium (+5,5%), Ireland (+3,3%), Germany (+3,0%), France (+2,5%). Also, the values in 2018 were lower than in 2004 in: Estonia (-20,2%), Romania (-8,4%), Lithuania (-8,3%), Cyprus (-5,3) %, Hungary (-5,0%), Finland (-5,0%), Sweden (-4,2%), Austria (-3,9%), Greece (-2,2%), Portugal (-1,6%). For 2018, the highest shares of waste generation were registered in: Estonia (29,4), Netherlands (27,9), Belgium (26,4), Italy (22,9), Spain (16,4), Bulgaria (15,2). At the same time, the lowest values are observed for: Romania (4,8%), Latvia (4,8%), Cyprus (5,2%), Ireland (6,6%), Hungary (7,0%), Finland (7,4%), Denmark (7,4%), Portugal (8,1%),

At European level, the following figure shows the evolution of waste generation (excluding major mineral wastes per domestic material consumption), for the period 2004-2018 (%).

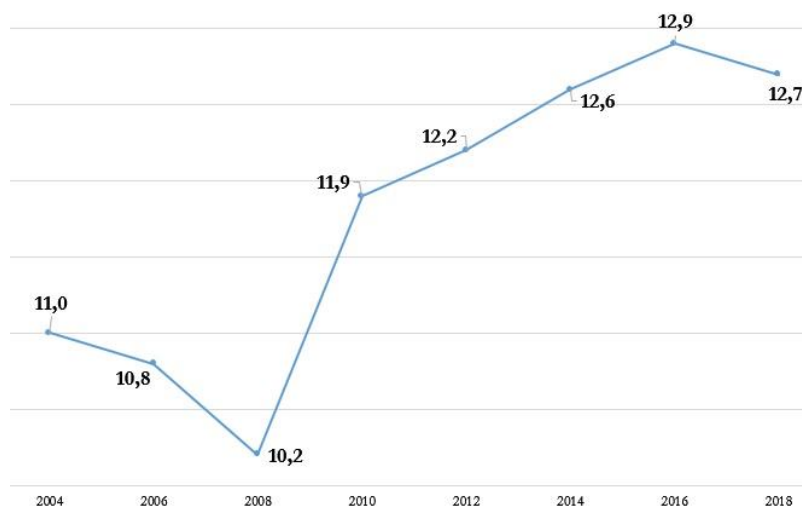


Figure 2: Evolution of waste generation (excluding major mineral wastes per domestic material consumption), 2004-2018

Source: processing according to data published by EUROSTAT, 2021

From the previous figure, it is observed that in the period 2004-2008 there was a decrease in the share of generation of waste (excluding major mineral wastes per domestic material consumption). For this indicator, the period 2008-2016 showed an increase in values (from 10,2% to 12,9%). Also, for the period 2016-2018 there is a decreasing trend (from 12,9% to 12,7%).

Another important indicator is the recycling rate of all waste. The following table presents the comparative situation of the recycling rate of all waste (excluding major mineral waste), for the period 2010-2018.

Table 3: Comparative situation of recycling rate of all waste (excluding major mineral waste), 2008-2018

Countries	2010	2012	2014	2016	2018
European Union	53	53	54	55	55
Belgium	75	80	81	78	81
Bulgaria	27	14	17	27	23
Czechia	50	58	60	60	61
Denmark	56	59	60	61	59
Germany	55	54	53	:	53
Estonia	22	25	19	10	:
Ireland	36	37	45	41	41
Greece	:	:	:	:	:
Spain	44	46	46	46	47
France	50	51	53	54	52
Croatia	26	35	47	52	56
Italy	60	64	67	68	67
Cyprus	46	34	31	31	32
Latvia	:	:	:	:	50
Lithuania	50	51	57	68	72
Luxembourg	87	77	62	64	70
Hungary	36	35	40	43	49
Malta	24	28	27	43	28
Netherlands	71	71	72	72	66
Austria	60	65	62	66	63
Poland	58	55	60	56	58
Portugal	47	49	54	52	54
Romania	26	28	27	30	29
Slovenia	52	74	75	80	82
Slovakia	38	40	40	44	50
Finland	33	41	41	37	37
Sweden	51	53	51	49	50

Source: processing according to data published by EUROSTAT, 2021

It is observed that in 2018, compared to 2010, the share of recycling rate of all waste (excluding major mineral waste) increased for: Croatia (+30%), Slovenia (+30%), Lithuania (+22%), Hungary (+13%), Slovakia (+12%), Czechia (+11%). Decreases in values were recorded in: Luxembourg (-17%), Cyprus (-14%), Netherlands (-5%), Bulgaria (-4%), Germany (-2%), Sweden (-1%).

Of the entire amount of waste recycled, it is important to recycle municipal waste. The following table presents the comparative situation of the recycling rate of municipal waste for the period 2008-2018 (thousand tons).

Table 4: Comparative situation of recycling rate of municipal waste, 2008-2018

Countries	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
European Union	36,5	37,3	38,0	38,9	40,9	41,5	43,4	44,9	46,5	47,0	47,2
Belgium	52,7	53,9	54,8	54,4	53,4	52,8	53,8	53,5	53,5	53,9	54,4
Bulgaria	19,4	19,9	24,5	26,2	25,0	28,5	23,1	29,4	31,8	34,6	31,5
Czechia	10,4	12,4	15,8	17,0	23,2	24,2	25,4	29,7	33,6	32,0	32,2
Denmark	47,9	48,8	:	42,4	42,5	43,3	45,4	47,4	48,3	47,6	49,9
Germany	63,8	63,1	62,5	63,0	65,2	63,8	65,6	66,7	67,1	67,2	67,1
Estonia	20,2	21,0	18,2	23,3	19,1	17,9	31,3	28,3	28,1	28,4	28,0
Ireland	33,6	33,5	35,7	36,1	36,6	:	39,8	:	40,7	40,4	37,6
Greece	17,7	18,9	17,1	17,8	17,0	15,8	15,4	15,8	17,2	18,9	20,1
Spain	39,7	33,2	29,2	26,7	29,8	32,5	30,8	30,0	33,9	36,1	34,8
France	33,8	35,3	36,0	36,8	37,7	38,7	39,7	40,7	42,9	44,1	45,1
Croatia	2,8	2,3	4,0	8,3	14,7	14,9	16,5	18,0	21,0	23,6	25,3
Italy	23,8	29,7	31,0	35,5	38,4	39,4	41,6	44,3	45,9	47,8	49,8
Cyprus	7,5	8,3	10,9	11,0	12,5	13,9	14,8	16,6	16,1	16,2	16,5
Latvia	6,4	7,7	9,4	9,7	14,7	25,9	27,0	28,7	25,2	24,8	25,2
Lithuania	8,5	8,5	4,9	19,9	23,5	27,8	30,5	33,1	48,0	48,1	52,5
Luxembourg	46,0	46,2	46,5	46,4	47,4	46,6	47,7	47,4	49,2	48,7	49,0
Hungary	15,2	15,4	19,6	22,0	25,5	26,4	30,5	32,2	34,7	35,0	37,4
Malta	3,6	3,7	5,2	9,0	9,7	8,5	7,4	10,9	12,3	10,9	10,0
Netherlands	48,4	49,1	49,2	49,1	49,4	49,8	50,9	51,8	53,5	54,6	55,9
Austria	63,2	61,9	59,4	56,7	57,7	57,7	56,3	56,9	57,6	57,7	57,7
Poland	10,5	13,2	16,3	11,4	12,0	15,1	26,5	32,5	34,8	34,8	33,8
Portugal	17,3	19,5	18,7	20,1	26,1	25,8	30,4	29,8	30,9	29,1	29,1
Romania	0,9	1,1	12,8	11,7	14,8	13,2	13,1	13,2	13,4	14,0	11,1
Slovenia	18,9	19,6	22,4	35,6	41,9	34,8	36,0	54,1	55,6	57,8	58,9
Slovakia	7,4	8,2	9,1	10,8	13,4	10,8	10,3	14,9	23,0	29,8	36,3
Finland	34,3	35,9	32,8	34,8	33,3	32,5	32,5	40,6	42,0	40,5	42,3
Sweden	45,6	49,2	47,8	47,0	46,9	48,2	49,3	47,5	48,4	46,8	45,8

Source: processing according to data published by EUROSTAT, 2021

From the data presented, it is observed that the recycling rate of municipal waste increased in 2018 compared to 2008 for: Lithuania (+44,0 thousand tons), Slovenia (+40,0 thousand tons), Slovakia (+28,9 thousand tons), Italy (+26,0 thousand tons), Poland (+23,3 thousand tons), Croatia (+22,5 thousand tons), Hungary (+22,2 thousand tons), Czechia (+21,8 thousand tons). Also, the values of this indicator decreased for: Austria (-5,5 thousand tons) and Spain (-4,9 thousand tons).

In 2018, the countries where the recycling rate of municipal waste was the highest are: Germany (67,1 thousand tons), Slovenia (58,9 thousand tons), Austria (57,7 thousand tons), Netherlands (55,9 thousand tons), Belgium (54,4 thousand tons), Lithuania (52,5 thousand tons). At the same time, low values were registered in: Malta (10,0 thousand

tons), Romania (11,1 thousand tons), Cyprus (16,5 thousand tons), Greece (20,1 thousand tons), Latvia (25,2 thousand tons), Croatia (25,3 thousand tons), Estonia (28,0 thousand tons), Portugal (29,1 thousand tons).

The evolution of the recycling rate of municipal waste, for the period 2008-2018, at European level is presented in the following figure.

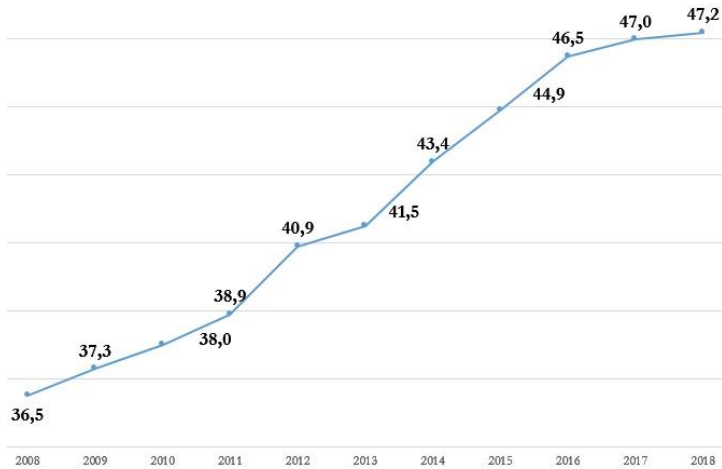


Figure 3: Evolution of recycling rate of municipal waste, 2008-2018

Source: processing according to data published by EUROSTAT, 2021

For the analyzed period, the recycling rate of municipal waste increased from 36.5 thousand tons to 47.2 thousand tons. The trend is upward.

For the circular economy of major importance is also the recycling of biowaste. The following table presents the comparative situation of recycling of biowaste, for the period 2008-2018 (kilograms per capita).

Table 5: Comparative situation of recycling of biowaste, 2008-2018

Countries	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
European Union	69	67	66	66	69	71	73	75	82	85	84
Belgium	98	95	97	93	93	92	87	80	85	81	82
Bulgaria	0	0	0	11	13	15	8	43	37	34	7
Czechia	5	5	7	7	8	9	9	13	23	50	50
Denmark	114	134	:	121	125	130	141	151	153	154	143
Germany	98	102	101	106	110	106	114	114	116	114	109
Estonia	21	32	24	27	14	15	17	13	10	14	15
Ireland	24	19	23	34	34	:	39	:	40	51	50
Greece	9	3	13	14	16	17	15	12	17	21	26
Spain	134	97	59	49	48	77	62	53	72	84	80
France	82	85	85	86	87	89	91	93	104	106	108
Croatia	3	3	3	3	6	7	8	7	7	9	12
Italy	53	59	67	67	73	72	80	86	94	98	105
Cyprus	0	0	0	0	8	9	19	21	19	9	11
Latvia	3	1	2	4	6	20	13	24	42	29	25

Countries	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Lithuania	5	5	6	8	17	32	41	46	104	109	131
Luxembourg	138	135	133	120	128	111	121	111	167	153	154
Hungary	8	9	15	18	18	19	24	23	30	32	32
Malta	0	0	0	7	12	0	0	0	0	0	0
Netherlands	142	145	139	141	140	137	143	143	144	144	147
Austria	202	186	182	188	196	192	175	175	181	182	187
Poland	10	4	5	6	5	6	15	17	21	21	22
Portugal	36	40	38	42	66	57	64	72	79	83	86
Romania	0	0	32	22	29	23	20	18	18	18	9
Slovenia	8	10	11	22	21	28	30	34	69	73	79
Slovakia	12	12	11	13	15	13	17	24	26	33	39
Finland	44	57	62	66	60	67	70	62	65	67	72
Sweden	57	60	60	64	65	69	72	70	72	70	69

Source: processing according to data published by EUROSTAT, 2021

It is noted that in 2018 compared to 2008, only for four countries the values decreased: Spain (-54 kilograms per capita), Belgium (-16 kilograms per capita), Austria (-15 kilograms per capita), Estonia (-6 kilograms per capita). The highest increases were also recorded in: Lithuania (+126 kilograms per capita), Slovenia (+71 kilograms per capita), Italy (+52 kilograms per capita), Portugal (+50 kilograms per capita), Czechia (+45 kilograms per capita). In 2018, the lowest quantities of recycled biowaste were recorded in: Bulgaria (7 kilograms per capita), Romania (9 kilograms per capita), Cyprus (11 kilograms per capita), Croatia (12 kilograms per capita), Estonia (15 kilograms per capita). At the same time, the largest quantities of biowaste were recycled in: Austria (187 kilograms per capita), Luxembourg (154 kilograms per capita), Netherlands (147 kilograms per capita), Denmark (143 kilograms per capita), Lithuania (131 kilograms per capita) per capita, Germany (109 kilograms per capita), France (108 kilograms per capita), Italy (105 kilograms per capita). At European level, in 2017 compared to 2008, there is an increase of 15 kilograms per capita in the quantities of recycled biowaste. The evolution is shown in the following figure.

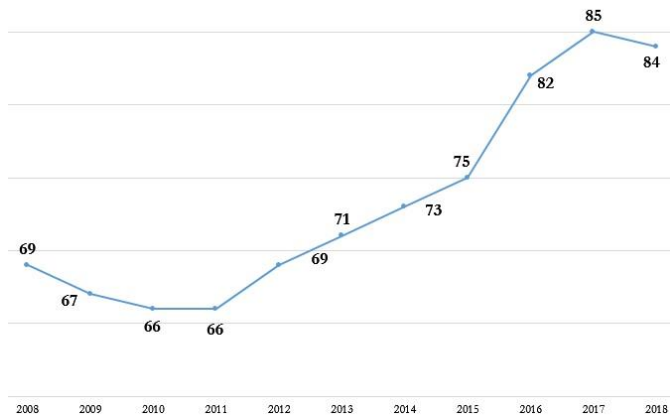


Figure 4: Evolution of recycling of biowaste, 2008-2018
 Source: processing according to data published by EUROSTAT, 2021

Another important indicator for the circular economy is circular material use rate. For the period 2010-2018, the comparative situation is presented in the following table (%).

Thus, compared to 2010, in 2018 circular material use rate increased in: Italy (+7,3%), Belgium (+6,9%), Estonia (+4,7%), Austria (+4,5%), Slovenia (+4,1%). Also, circular material use rate decreased in: Luxembourg (-13,3%), Finland (-7,6%), Romania (-2,0%), Spain (-1,1%), Poland (-1,0%), Sweden (-0,6%), Slovakia (-0,2%), Ireland (-0,1%). In 2018, the lowest values were registered in: Romania (1,5%), Ireland (1,6%), Portugal (2,2%), Bulgaria (2,5%), Cyprus (2,8%), Greece (3,3%). At the same time, high rates were in: Netherlands (28,9%), Belgium (19,9%), France (19,5%), Italy (18,8%), Estonia (13,5%), Germany (11,7%), Austria (11,1%), Luxembourg (10,8%), Slovenia (10,0%),

Table 6: Comparative situation of circular material use rate, 2010-2018, (%)

Countries	2010	2011	2012	2013	2014	2015	2016	2017	2018
European Union	10,7	10,2	11	11,2	11,1	11,2	11,4	11,4	11,5
Belgium	13	14	16,9	16,8	17,6	17,7	17,6	18,5	19,9
Bulgaria	2,1	1,8	1,9	2,5	2,7	3,1	4,4	3,5	2,5
Czechia	5,3	5,4	6,3	6,7	6,8	6,9	7,5	7,9	8
Denmark	8	7	6,4	7,7	9	8,3	8	7,9	8,1
Germany	11	10,4	10,7	10,9	10,8	11,5	11,6	11,3	11,7
Estonia	8,8	14,2	19,1	14,6	10,9	11,3	11,6	12,4	13,5
Ireland	1,7	2,1	1,8	1,7	2	1,9	1,7	1,7	1,6
Greece	2,7	2,2	1,9	1,8	1,4	1,9	2,3	2,8	3,3
Spain	10,4	9,8	9,8	8,9	7,7	7,5	8,2	8,9	9,3
France	17,5	16,8	16,9	17,3	17,8	18,7	19,4	18,8	19,5
Croatia	1,6	2,4	3,6	3,9	4,8	4,6	4,6	5,2	5
Italy	11,5	11,6	13,9	16	16,1	17,2	17,8	18,4	18,8
Cyprus	2	1,9	2	2,4	2,2	2,4	2,4	2,4	2,8
Latvia	1,2	2,9	1,3	3,8	5,3	5,3	6,5	5,4	4,7
Lithuania	3,9	3,6	3,8	3,1	3,7	4,1	4,6	4,5	4,3
Luxembourg	24,1	20,7	18,5	15,4	11,3	9,7	7,1	10,6	10,8
Hungary	5,3	5,4	6,1	6,2	5,4	5,8	6,5	6,9	7
Malta	5,3	4,5	3,9	6,3	6,4	4,6	4,2	6,5	8,3
Netherlands	25,3	25	26,5	27,1	26,6	25,8	28,5	29,7	28,9
Austria	6,6	6,8	7,5	8,7	9,6	10,7	11,2	11,4	11,1
Poland	10,8	9,2	10,6	11,8	12,6	11,6	10,2	9,9	9,8
Portugal	1,8	1,7	2	2,5	2,4	2,1	2,1	2	2,2
Romania	3,5	2,5	2,6	2,5	2,1	1,7	1,7	1,7	1,5
Slovenia	5,9	7,6	9,3	9,3	8,5	8,6	8,7	9,8	10
Slovakia	5,1	4,8	4,1	4,6	4,8	5,1	5,3	5	4,9
Finland	13,5	14	15,3	10,1	7,3	6,4	5,3	5,6	5,9
Sweden	7,2	7,6	8,2	7,2	6,4	6,7	6,8	6,7	6,6

Source: processing according to data published by EUROSTAT, 2021

Higher values of circular material use rate imply an increase in the share of replacement of raw materials with secondary materials, resulting in the production process.

5. Conclusions

It is hoped that the circular economy will be a path to sustainable development. But high circularity must be based on the sustainability of both the environment and the economy and society. Thus, an assessment of the degree of recirculation of materials is not enough to measure how much resource use has decreased. This is because pollutant emissions or high energy consumption can occur that influence the values of circularity (Corona et al., 2019).

At European level, in 2018, compared to 2008, the amount of municipal waste generated in Kilograms per capita decreased, even if the values differ from one country to another. At the same time, the generation of waste (excluding major mineral wastes per domestic material consumption) has increased. Also, the recycling rate of municipal waste has increased in most countries, and the trend is increasing. At the same time, there is interest in recycling of biowaste. The values of this indicator indicate an increasing trend for most countries.

In order to be able to apply the transition to a sustainable circular economy, it is necessary to carry out an assessment of both the components of the system (individual products) and an assessment of the whole system (the whole economy). Optimal solutions can be identified only by considering the qualitative aspects of materials and by considering a whole life cycle (Haupt & Hellweg, 2019).

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