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Circular economy education at higher education in CA countries

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Development of innovative curricula and modules in Circular Economy and Sustainable Development

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1. Introduction and Background

The urgency for adopting a circular economy is more critical than ever. Annually, over 100 billion tons of materials—ranging from metals and minerals to fossil fuels and biological resources derived from flora and fauna—are consumed globally. However, only a mere 8.6% of these materials are recycled and reused. Since 1970, our resource consumption has tripled and is on track to double once more by 2060 if current trends persist unchecked. To maintain our present rate of resource utilization in a sustainable manner, the capacity of 1.5 Earths would be necessary.

Central Asia is highly vulnerable to natural disasters and environmental pressures, which threaten progress in poverty reduction and shared prosperity. Climate change exacerbates these pressures, affecting arable land, leading to food insecurity, and constraining economic growth, especially impacting rural communities dependent on the land[1].

In the global movement toward sustainable development, the circular economy has emerged as a pivotal strategy, particularly in resource-dependent regions like Central Asia. The shift from a linear to a circular economy not only promises environmental benefits but also enhances economic resilience by reducing dependency on raw material imports, fostering innovation, and creating new job opportunities. For Central Asia, this transition holds the potential to mitigate the adverse effects of climate change and environmental degradation, especially in rural communities that rely heavily on agriculture and natural resources.

However, despite growing recognition of the importance of circular practices, the region faces significant challenges in implementing them. These challenges include limited data on resource use, recycling rates, and waste management, which impede the development and monitoring of circular economy policies. Moreover, the region lacks established indicators and infrastructure to measure and promote circularity effectively. Countries like Kazakhstan and Uzbekistan are making strides in policy development and waste recycling, but other nations, such as Turkmenistan and Tajikistan, lag behind in policy frameworks and innovation.

To fully realize the benefits of a circular economy, it is essential to integrate these principles into various sectors, including education. Higher education institutions play a crucial role in shaping future leaders and professionals who can drive the transition to a circular economy. As such, it is vital to evaluate and enhance the integration of circular

[1]https://www.undp.org/kyrgyzstan/press-releases/green-economy-forum-discuss-green-economy-development-central-asia

economy concepts in the curricula of Central Asian universities, ensuring that students acquire the necessary skills and knowledge to contribute to sustainable development.

This report seeks to analyze the current state of circular economy education in Central Asia, assess national policies supporting circular practices, and propose strategies to enhance the adoption of circular economy principles in the region. It also explores the potential for higher education institutions to play a central role in this transition, contributing to sustainable development across Central Asia.

Objectives

- to analyze the performance of Central Asian countries in circular economy ensuring consistency and comparability across the region
- to evaluate the current integration of circular economy principles and sustainability practices within higher education curricula in Central Asian countries
- to analyze the existing policy frameworks, legislation, and regulatory measures that support the adoption and implementation of circular economy principles in Central Asian countries
- to evaluate the current educational programs and curricula offered by partner universities in Central Asia concerning circular economy and sustainability
- to identify and evaluate the roles, interactions, and impacts of various stakeholders involved in advancing circular economy initiatives in Central Asia

2. Circular economy indicators in Central Asia countries

Definition and measurement

There is **no single indicator that can comprehensively measure the level of circularity** in a country; instead, a multifaceted approach is required, encompassing various dimensions and indicators. According to the European Commission's Monitoring Framework for the Circular Economy (2018), key indicators include **resource productivity, recycling rates, waste generation, and the contribution of circular economy activities to GDP**. This multi-indicator approach reflects the complexity and breadth of circular economy principles, which span environmental, economic, and social domains (Geissdoerfer et al., 2017). Thus, a combination of indicators provides a more holistic and accurate assessment of a country's progress towards a circular economy.

According to World Customs Organization, circular economy is an economic system that uses a systematic approach to maintain a circular flow of resources, by recovering, retaining or adding to their value, while contributing to sustainable development[2]. This contrasts with the traditional, linear economic system, which is mainly based on a 'take-make-consume-dispose' model.

Key methods and indicators include Material Flow Analysis (MFA) to gauge resource efficiency and material circularity (Haas et al., 2015), economic indicators such as GDP adjusted for environmental degradation and the contribution of circular economy activities to GDP (European Commission, 2018), and waste management metrics like recycling and landfill rates (OECD, 2019). Resource productivity is assessed through resource use per unit of GDP and resource extraction levels, while environmental impact is measured using carbon and ecological footprints (Global Footprint Network, 2019). Innovation and investment indicators include R&D expenditure and the growth of circular economy startups (Ellen MacArthur Foundation, 2015). Policy and governance effectiveness are evaluated by the presence of circular economy policies and public awareness (European Environment Agency, 2016). Social indicators track employment in circular sectors and the availability of related training programs (OECD, 2019). Sector-specific indicators focus on the recycling and reuse rates in industries like construction, textiles, and packaging (EMF, 2015). Circularity gap reporting measures the proportion of materials cycled back into the economy (Circle Economy, 2020). Robust data collection and analysis by national statistics agencies, environmental agencies, industry reports, and surveys are crucial. International frameworks and standards, such as ISO 14000, SDG indicators, and the European Commission's circular economy indicators, provide additional structure for assessment (ISO, 2015; UN, 2015; European Commission, 2018).

A series of ISO 59 000 international standards have been developed recently, namely

[2]https://www.wcoomd.org/-/media/wco/public/global/pdf/events/2022/greener-hs/session-3/iso-tc-323-iso_international-standardization-activities-in-the-circular-economy.pdf?la=en

ISO 59004:2024 – Circular Economy - Vocabulary, principles and guidance for implementation[3]

ISO 59010:2024 – Circular Economy - Guidance on the transition of business models and value networks[4]

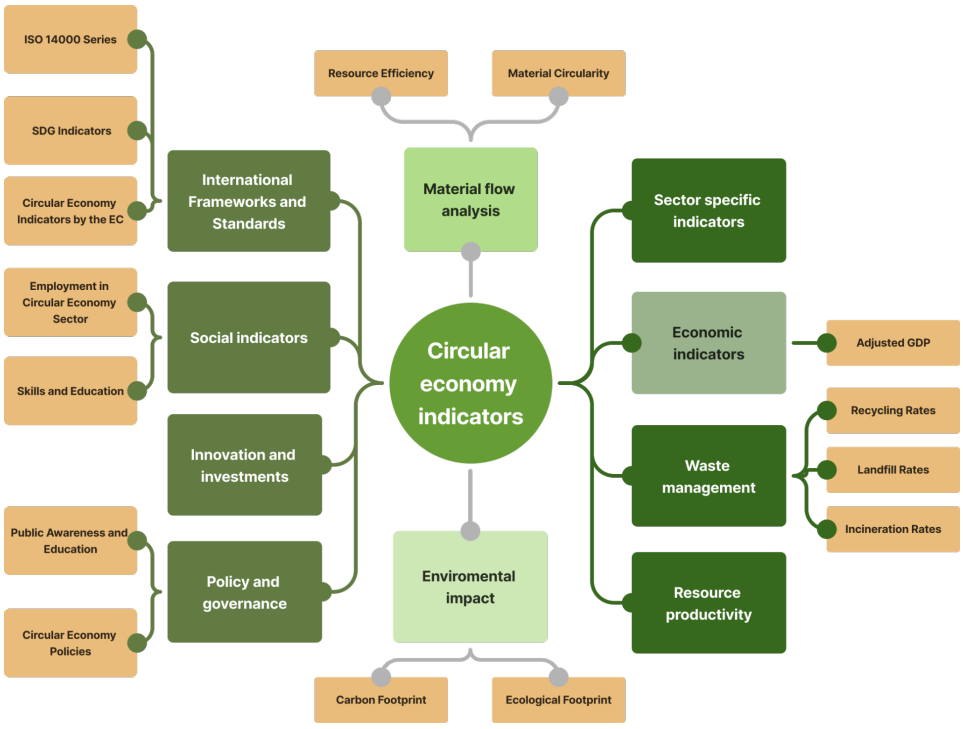
ISO 59020:2024 Circular Economy - Measuring and assessing circularity performance[5]

ISO/DIS 59040 Circular Economy – Product Circularity Data Sheet (under development)[6].

The ISO 59000 series of documents is designed to harmonize the understanding of the circular economy and to support its implementation and measurement. The series also supports organizations, such as government, industry, and non-profit organizations in contributing to the achievement of the UN Agenda 2030 for Sustainable Development[7].

Combining these indicators offers a comprehensive picture of an economy's circularity, aiding policymakers and stakeholders in identifying areas for improvement and tracking progress over time.

Figure 1: Circular Economy Indicators



Source: Own elaboration

[3] https://www.iso.org/standard/80648.html
[4] https://www.iso.org/standard/80649.html
[5] https://www.iso.org/standard/80650.html
[6] https://www.iso.org/standard/82339.html
[7] https://www.iso.org/obp/ui/en/#iso:std:iso:59040:dis:ed-1:v1:en

Most indicators for measuring the level of circularity are not readily available in Central Asia countries and the region in whole, primarily due to limited data collection infrastructure and varying levels of commitment to circular economy principles and practices introduced across the region together with the absence of established set of national and regional statistical indicators for measuring circularity.

According to the OECD (2019), Central Asian countries face significant challenges in obtaining accurate and comprehensive data on resource efficiency, recycling rates, waste management practices, and other key metrics necessary for assessing circular economy performance. This lack of data impedes the ability to implement effective policies and track progress, underscoring the need for enhanced statistical capabilities and greater regional cooperation to develop and standardize circular economy indicators.

Eurostat's Circular economy monitoring methodology

A comprehensive circular economy monitoring framework has been introduced by Eurostat, the statistical office of the European Union.

The framework consists of five thematic sections with a total of 11 statistical indicators, some of which have additional sub-indicators[8]:

- **production and consumption** (three statistical indicators: material consumption, green public procurement, waste generation);

- **waste management** (two statistical indicators: overall recycling rates; recycling rates for specific waste streams);

- **secondary raw materials** (two statistical indicators: contribution of recycled materials to raw materials demand; trade of recyclable raw materials between EU countries and with the rest of the world + two sub-indicators for measuring contribution of recycled materials to raw materials demand),

- **competitiveness and innovation** (two statistical indicators: private investments, jobs and gross value added; innovation);

- **global sustainability and resilience** (two statistical indicators: global sustainability from circular economy; resilience from circular economy. Each indicator has two sub-indicators.)

Most of the indicators in the framework are official statistics sourced by Eurostat. Others are produced by the Joint Research Centre and the department of European Commision called Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs.

It should be noted that the study of available statistical data on the websites of statistical agencies of the four countries under consideration shows that similar sets of

[8] https://ec.europa.eu/eurostat/web/circular-economy/information-data

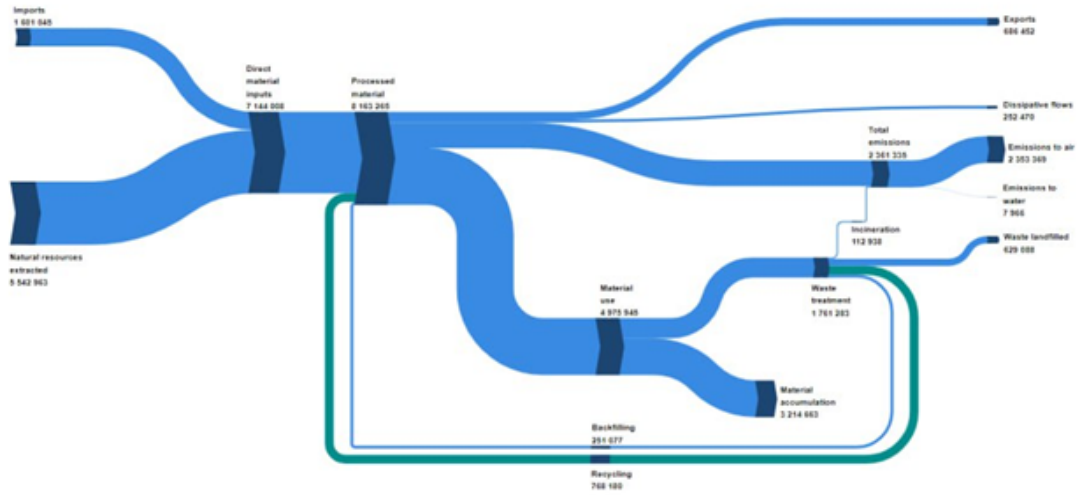
indicators are not established in the four Central Asian countries (Kazakhstan[9], Tajikistan[10], Turkmenistan[11], Uzbekistan[12]).

There are two Eurostat statistical products related to the circular economy, namely 1) a Sankey diagram of material flows in the European Union; and 2) the circular material use rate or circularity rate, i.e. the share of material recycled and fed back into the economy.

The Eurostat Sankey diagram of material flows shows the amounts of materials extracted, imported, recycled or disposed, as well as related emissions.

As of 2022, 68 percent (5.54 Gt) of raw materials processed in the EU (8.16 Gt) originate from domestic extraction, 20 percent from imports (1.60 Gt) and 12 percent from recycling and backfilling (1.02 Gt), while 61 per cent of raw materials processed were used to make products (4.98 Gt).

Figure 2: Material flow in European Union, i. e. Sankey diagram.



Source: Eurostat 2022

Eurostat developed an indicator for the EU monitoring framework for the circular economy aiming at measuring circularity at macroeconomic level. This indicator is called the 'circular material use rate' — referred to as the circularity rate — and it measures the contribution of recycled materials towards the overall use of materials.

The circularity rate is the share of material resources used in the EU which came from recycled waste materials, thus saving primary raw materials from being extracted. A higher circularity rate means that more secondary materials replace primary raw materials, thus reducing the environmental impacts of extracting primary material.

[9] https://stat.gov.kz/ru/
[10] https://www.stat.tj/ru/
[11] https://www.stat.gov.tm/
[12] ttps://stat.uz/ru/

In 2022, the rate of circularity of material use in the EU was 11.5 percent, 3.3 percentage points (pp) up from 2004.

The description of the diagram provided by Eurostat contains a number of conceptions such as ‘direct material input (DMI)’ , ‘recycling’ , ‘backfilling’ , ‘domestic material comsumption (DMC)’ , ‘recovery’ and others with certain links to the EU directives. For instance, the concept of recycling of waste is defined as in the Waste Framework Directive and the calculation of the recycling rate must be made as it is outlined in the Directive . For instance, recycling can be split into the subcategories – 'Material recycling' and the organic recycling 'Recycling - composting and digestion'. The latter is only possible for separately collected organic waste. According to the glossary, definitions for recycling and reuse in waste specific Directives partially deviate from the corresponding definitions of the Waste Framework Directive:

1. The term recycling specified in waste specific Directives does in particular not include backfilling operations.

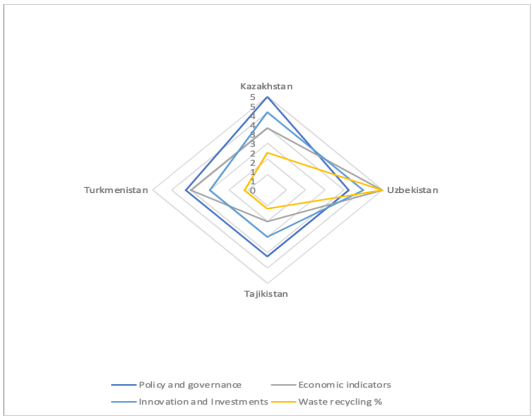
2. Reuse as defined in the Packaging Directive 94/62/EC and the WEEE Directive 2002/96/EC comprises specifications, the Waste Framework Directive does not include.

It should be noted that the absense of a developed national waste management regulation and relevant waste management practices and statistical indicators in place undermine all attempts to propose a similar calculation of circularity rate in the CA countrites. Meanwhile, a number of circular economy indicators can be used for evaluation of circularity in Central Asian countries (see figure 1.)

Evaluating Circular Economy Models in Central Asia

Based on the availability of the data in Central Asia, indicators on circular economy were gathered, analyzed and comparison was made. The radar chart below provides a comparative overview of circular economy indicators for Kazakhstan, Uzbekistan, Turkmenistan, and Tajikistan across four categories: Policy and Governance, Economic Indicators, Innovation and Investments, and Waste Recycling Percentage.

Figure 3: Comparative Analysis of Selected Circular Economy Indicators in Central Asian Countries

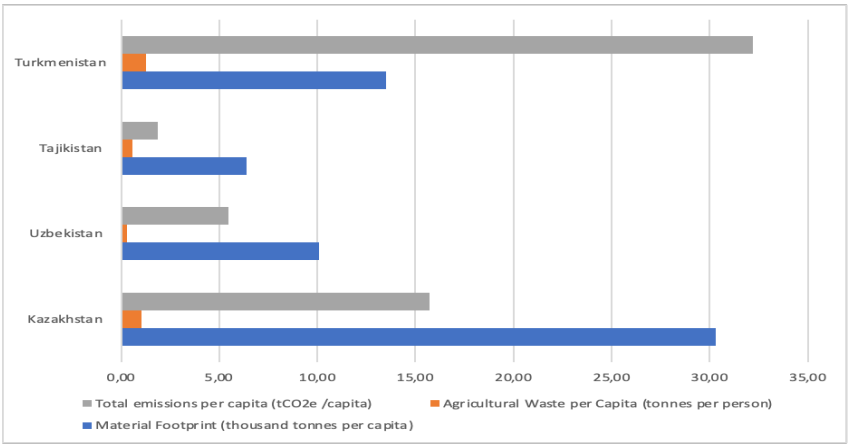


Source: Own elaboration

Kazakhstan leads in policy and governance, economic performance, and innovation and investments but still needs to improve its waste recycling practices. Uzbekistan shows a balanced performance with moderate scores in policy, economic indicators, and innovation, and stands out with the highest waste recycling rates. Turkmenistan and Tajikistan lag behind, with weaker policy frameworks, economic activities, and innovation efforts, and notably low waste recycling percentages. These findings suggest that while Kazakhstan and Uzbekistan are making strides towards a circular economy, there is a crucial need for Turkmenistan and Tajikistan to strengthen their policy frameworks, economic initiatives, and investment in circular practices. Overall, enhancing waste management and recycling remains a key area for improvement across the region to achieve sustainable development.

Qualitative indicators have been compared on the Figure below. The indicators presented are Total Emissions per Capita (tCO2e/capita), Agricultural Waste per Capita (tonnes per capita), and Material Footprint per Capita (tonnes per capita).

Figure 4: Comparasion of Selected Environmental Indicators in Central Asian Countries



Source: Own elaboration

The figure illustrates significant disparities in environmental indicators across Central Asian countries. Turkmenistan exhibits the highest per capita emissions and agricultural waste, indicating considerable environmental pressures. Kazakhstan shows high emissions and the largest material footprint, underscoring its resource-intensive economy. Uzbekistan presents moderate figures for emissions and material footprint but relatively high agricultural waste. Tajikistan, while having the lowest emissions and material footprint, still faces challenges with agricultural waste management.

More detailed information and data for each indicator are presented in the following chapters.

Policy and governance

The Countries are parties to a number of international treaties that regulate material flows, environmental impacts and require appropriate reporting. For instance, the four CA countries (Kazakhstan, Tajikistan, Turkmenistan and Uzbekistan) are parties to the Montreal Protocol on Substances that deplete the ozone layer, the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal. According to UNECE, sometimes countries have had difficulties fulfilling their reporting obligations under the Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal[13]. Due to the fact that reporting data is not available publicly on the websites of authorized national authorities, some data can be retrieved from general statistical reports compiled by national statistical agencies. Also, selected country statistics on green growth can be found on the OESD.Stat portal[14].

The four countries share a number of similar challenges such as lack of technical regulation since industry guidelines, as well as BREFs (Best Available Techniques Reference Documents) on resource saving and waste management are not mandatory and widely applied. This gap in technical regulation determines certain features of the economic model, which has more linear features than circular ones. In terms of technical regulation, the situation in Kazakhstan is comparatively better due to the fact that industry sector have been recently developed and applied in certain industries[15], Kazakh association on waste management is accelerating its activities to unite and enhance waste recycling enterprises activities across the country.

Also, most countries do not have developed legislation and, most importantly, practice waste sorting. Waste management is largely expressed in the creation of waste collection sites, waste transfer stations and large district and regional solid waste landfills. Waste ends up in landfills mainly in unsorted form, although in recent years the situation with

[13] https://uzbekistan.un.org/sites/default/files/2020-10/ECE.CEP_.188.Eng_.pdf, https://ers.basel.int/ERS-Extended/FeedbackServer/fsadmin.aspx?fscontrol=respondentReport&surveyid=83&voterid=56311&readonly=1&nomenu=1

[14] https://stats.oecd.org/

[15] https://igtipc.org/ru/best-available-techniques

waste sorting has improved somewhat. Also, there is no regulation on plastic packaging and electronic and electrical waste.

The four countries share the same challenges that can affect introducing and measuring circularity. One of them is **limited technical regulation** based on best available techniques and lack of presence of environmentally sound (proved green) technologies in the market, since BREFs (Best Available Techniques Reference Document), including those on resource saving, recycling and re-use as well as waste management, are not mandatory and widely applied in the industry (Uzbekistan[16],Tajikistan[17]). The situation in Kazakhstan is comparatively better since national BREFs have been recently developed and applied in certain industries[18]. Other countries do not apply mandatory BREFs across all economic sectors. For instance, in Uzbekistan's pilot green taxonomy the application of EU BREFs in waste management projects makes them eligible for green finance in the country.

In particular, **the lack of regulation of production, consumption, sorting and processing of plastic containers and packaging** in CA countries has led to a huge environmental pollution in the countries. In practice, a huge amount of unrecycled waste plastic containers and bags dumped on the ground in massive landfilds have become one of the main environmental threats in Central Asian countries. In recent years, separate regulatory norms have been introduced in Kazakhstan and Uzbekistan prohibiting the production of certain types of plastic packaging and containers and streamlining collection and processing of plastic wastes.

According to the Central Asia Waste Management Outlook 2019, in the last years all the Central Asia countries have shown remarkable progress in improving waste governance by introducing or revising waste legislation, programmes, policies, structures and incentives.[19] All the countries charge user fees for the collection and disposal of household waste, though these are typically low, and the revenues are barely enough to cover the costs. Waste disposal is of low quality and open landfills are still in widespread use across the region. Recycling is mainly a private activity, and the infrastructure to increase recycling rates or introduce selective collection is still lacking.

Economic indicators

The concept of Circular GDP is relatively new in Central Asian countries, and its current contribution to the overall GDP is still developing. Kazakhstan and Uzbekistan show emerging and growing contributions from circular activities, respectively, driven by government initiatives and sectoral opportunities. Tajikistan and Turkmenistan have modest contributions, with potential for growth in sustainable agriculture and energy efficiency.

Currently, the countries have not established any region-wide indicators to comparably measure the circular economy. Methodology and metrics for transition towards green

[16]https://uzbekistan.un.org/sites/default/files/2020-10/ECE.CEP_.188.Eng_.pdf
[17]https://unece.org/DAM/env/epr/epr_studies/Synopsis/ECE_CEP_180_Tajikistan_Synopsis_rus..pdf
[18] https://igtipc.org/ru/best-available-techniques
[19] https://zoinet.org/wp-content/uploads/2018/02/CA-waste-eng.pdf

economy have not been introduced thoroughly in national statistical reporting. Meanwhile, in Kazakhstan, for instance, developing and implementing relevant indicators to measure the country's circular economy model is a subject of active scientific research.

OECD uses Green Growth indicators but the data related to the CA countries are sometimes not available.

Indicators of the achievement of national sustainable development goals can also be used to assess a country's progress towards a circular economy, in particular indicators measuring progress towards achievement of the SDG 12 Responsible consumption and production (when available). Some data on circularity indicators in CA countries are available on the United Nations Global SDG Database.

Based on available literature, reports, and expert assessments of the circular economy activities within each region, the table below provides a structured comparison of the circular GDP contributions in Central Asian countries, highlighting the varying degrees of adoption and impact of circular economy activities.

Table 1: Circular GDP contribution in CA countries

Country	Circular Economy Activities	Current Contribution to GDP
Kazakhstan	Waste recycling, renewable energy, resource efficiency	Modest
Tajikistan	Agricultural waste management, small-scale recycling	Low
Turkmenistan	Renewable energy, energy efficiency	Modest
Uzbekistan	Waste recycling, renewable energy, sustainable agriculture	Growing

Source: Own elaboration

Kazakhstan's active promotion of circular economy principles through the Green Economy Concept, including initiatives in waste recycling and renewable energy projects, supports the classification of its circular GDP contribution as modest. In Tajikistan, there is limited adoption of circular economy practices, primarily focused on agricultural waste management and small-scale recycling efforts. Initial steps towards circular economy practices, particularly in the energy sector in Turkmenistan demonstrate modest contributions to the national GDP from renewable energy and energy efficiency

projects. Growing contributions from waste recycling, renewable energy, and sustainable agriculture initiatives shows that circular GDP contribution is growing in Uzbekistan.

Material flow analysis

The table below presents the material footprint, measured in tonnes per capita, for Kazakhstan, Tajikistan, Turkmenistan, Uzbekistan, and the European Union (EU). The material footprint is an important indicator of resource use and environmental impact, reflecting the amount of raw materials extracted to meet consumption needs.

Table 2. Material footprint in the CA countries

Indicator / Country	Kazakhstan	Tajikistan	Turkmenistan	Uzbekistan	EU
Material footprint, tonnes per capita	30,2858	6,3898	13,5115	10,0809	15

Source: The United Nations Global SDG Database. The data for the EU are as of year 2022. The data for CA countries are given as of year 2019

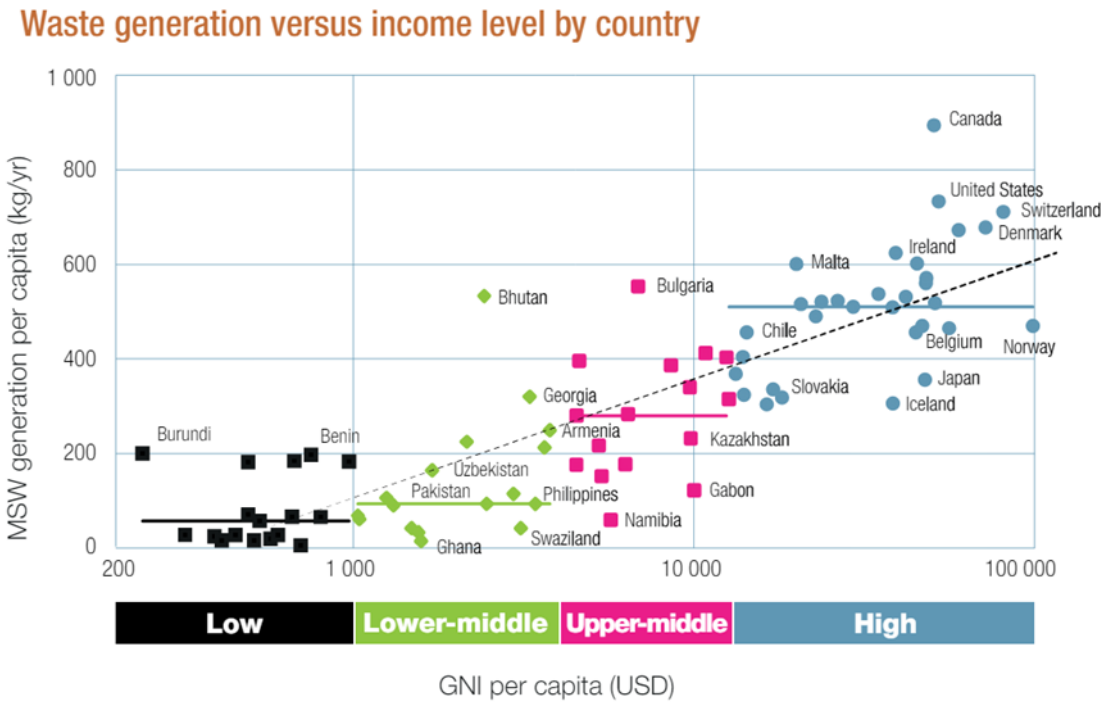
This table highlights significant disparities in material footprint among the CA countries and compared to the EU. Kazakhstan has the highest material footprint per capita at 30.2858 tonnes, significantly higher than the EU average of 15 tonnes. It's important to note that Kazakhstan's high material footprint is partly influenced by its low population density, which can lead to higher per capita values for resource use and extraction. Tajikistan has the lowest material footprint among the CA countries at 6.3898 tonnes per capita. These variations indicate differing levels of resource consumption and environmental impact, underscoring the need for tailored circular economy strategies within each country.

Waste management

The CA countries are parties to a number of international treaties such as the Montreal Protocol on Substances that deplete the ozone layer and Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, The Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade.

According to UNECE, sometimes countries have had difficulties fulfilling their reporting obligations under the Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal. Due to the fact that reporting data is not available publicly, some data can be retrieved from general statistical reports compiled by national statistical agencies.

Figure 5: Municipal Solid Waste generation per capita (kg/yr) versus income level by country.



Source: Global Waste Management Outlook, 2015

According to the MSW indicator, Kazakhstan and Uzbekistan have the highest MSW generation, reflecting their larger urban populations and economic activities. Tajikistan and Turkmenistan generate less MSW, corresponding with their smaller urban populations and lower economic activity. As well, Kazakhstan produces a massive amount of industrial waste due to its extensive mining activities. Data for industrial waste in Tajikistan, Turkmenistan, and Uzbekistan are less comprehensive but indicate significant contributions from key sectors.

Table 3: Waste generation and material footprint in CA countries and the EU.

Indicator	Kazakhstan	Tajikistan	Turkmenistan	Uzbekistan	EU
Municipal Solid Waste (MSW)	4.2 million tonnes	1.2 million tonnes	1.5 million tonnes	4 million tonnes	225.7 million tonnes
Industrial Waste	700 million tonnes	N/A	N/A	N/A	1.9 billion tonnes
Hazardous Waste	400,000 tonnes	N/A	N/A	N/A	101 million tonnes
Material Footprint (tonnes per capita)	30.29	6.39	13.51	10.08	15

Sources: The United Nations Global SDG Database, European Environment Agency (EEA), OECD.

Kazakhstan is noted for its hazardous waste generation, linked to its industrial activities. Other CA countries likely generate hazardous waste as well, but detailed data are limited. Kazakhstan has the highest material footprint per capita, significantly exceeding other CA countries and the EU. This high footprint is influenced by extensive natural resource extraction and a low population density.

Table 4: Agricultural Waste Data in Central Asian Countries

Country	Agricultural Waste Generation (million tonnes annually)	Agricultural Waste per Capita (tonnes per person)	Types of Waste	Current Management Practices
Kazakhstan	20	1.04	Crop residues (wheat, barley, corn), animal manure, agro-industrial by-products	Predominantly open burning of crop residues and unmanaged decomposition of animal waste
Tajikistan	6	0.60	Crop residues (cotton, wheat, fruits), animal manure	Limited infrastructure, common practices include open burning and minimal composting
Turkmenistan	8	1.28	Crop residues (cotton, wheat, fruits), animal manure	Open burning and inadequate management of animal waste
Uzbekistan	10	0.28	Crop residues (cotton, wheat, vegetables), animal manure	Predominantly open burning and traditional waste disposal methods, with emerging interest in composting and biogas production

Source: Own elaboration

Agricultural waste management in Central Asian countries (Table) presents significant environmental challenges due to prevalent practices such as open burning and unmanaged decomposition. Kazakhstan, generating the highest volume of agricultural waste at 20 million tonnes annually, predominantly deals with crop residues and animal manure through environmentally harmful methods. Similar issues are observed in Tajikistan and Turkmenistan, with agricultural waste generation of 6 million and 8 million tonnes respectively, where limited infrastructure leads to open burning and minimal composting. These practices contribute to air pollution, greenhouse gas emissions, and soil degradation. Uzbekistan, producing 10 million tonnes of agricultural waste annually, shares these challenges but shows emerging interest in sustainable waste management practices like composting and biogas production.

The waste management practices in Central Asian countries exhibit significant disparities and common challenges. Kazakhstan and Uzbekistan generate higher volumes of waste and show some progress in waste recycling and the development of modern landfills, but

still struggle with open dumping and incomplete waste collection coverage. Tajikistan and Turkmenistan, with lower waste generation, face substantial gaps in waste collection and poorly controlled disposal sites, with minimal recycling efforts.

Table 5. Waste management indicators in the CA countries

Country	Waste generation (mln tonnes per year)		Waste collection coverage, %			Waste recycling	Waste disposal
	Municipal	Industrial	Private	Public	Waste collection is lacking		
Kazakhstan	300	3-6	40	30	30	2% Rising	Modern landfills and disposal methods are growing; Open dumping is still a common practice
Tajikistan	0.6-2	No data	10	30	60	1% Rising	Poorly controlled waste site Open dumping is still a common practice
Turkmenistan	0.5-1	0.5-1		50	60	1% Rising	Poorly controlled waste site Open dumping is still a common practice
Uzbekistan	100	4	60		40	5-10% (30% as of 2022) Rising	Modern landfills and disposal methods are growing; Open dumping is still a common practice

Source: Central Asia Waste Management Outlook 2019.

GDP - composition, by sector of origin: agriculture: 4.8%; industry: 34.4%; services: 60.8% (2017 est.)[20]

Meanwhile, there is an increase in the processing of paper, polyethylene, glass, and food waste. To a lesser extent, scrap metal, wood, and textiles are processed in the country. Some companies specialize in processing automotive components: batteries, used oils, and tires. There is also a developing business in the processing and disposal of waste electrical and electronic equipment[21].

In Kazakhstan only one of the recommended by EU and OECD groups of circular economy indicators, namely waste management sector indicators, are being applied nowadays[22]. Based on the data in the table below, we see that for the specified seven-year period, there is mainly a positive trend in recycling and reuse of all types of waste, except hazardous types, where there is not only a decrease, but also a significant fluctuation over some years.

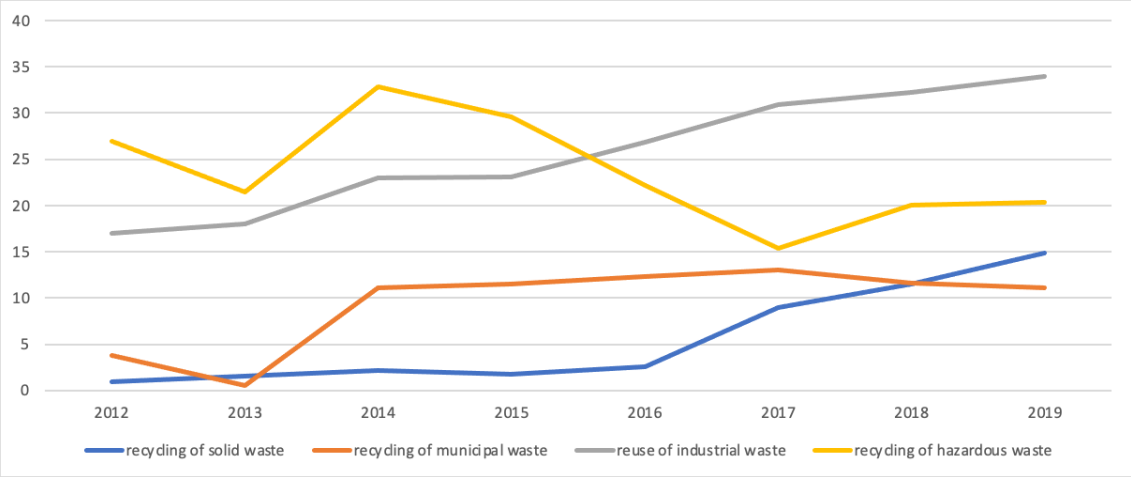


Figure 6: Dynamics of indicators of recycling and reuse of waste used in Kazakhstan by years.

Source: Tleppayev A.M., Zeinolla S.Zh. Assessment of Indicators of the Circular Economy on the Example of the Countries of the European Union and the Possibility of Application in the Conditions of Kazakhstan. Economics: the strategy and practice. 2021;16(3):128-141.

E-waste. The Ministry of Ecology and Natural Resources of Kazakhstan conducts National Monitoring of Electronic Waste 2023[23]. According to UNITAR, in Kazakhstan, the volume of electronic and electric equipment (EEE) placed on the market in 2019 amounted to 221.6 thousand tons (11.8 kg per capita). The volume of e-waste generation amounted to 136.1 thousand tons of e-waste (7.3 kg per capita), and the collection and

20 https://www.economy.com/kazakhstan/indicators

21 https://www.kaznu.kz/ru/3/news/one/35416/

22 https://esp.ieconom.kz/jour/article/view/441/292

23 https://ewastemonitor.info/wp-content/uploads/2023/07/National_E-waste_Monitor_Kazakhstan_A4_landscape_RU.pdf

processing of e-waste amounted to 11.9 thousand tons (0.6 kg per capita), which is 8.8% of the volume of e-waste generated.

Kazakhstan is the only country in the region that has introduced extended producer responsibility (EPR) and the EPR national operator. Relatively detailed waste statistics exist along with targets on waste collection and recycling. The Kazakhstan Waste Association is considered a unique platform in Central Asia that works with private sector, NGOs, citizens and governmental agencies to promote sound waste practices[24].

In Kazakhstan in 2022, emissions of pollutants into the air from stationary sources amounted to 2,314.7 thousand tons and their level decreased by 3.8% compared to the previous year[25].

Case study: Tajikistan

The country's economy is built on mineral extraction, metal processing and agriculture. GDP by sector: 28.6% from agriculture, 25.5% from manufacturing, 45.9% services[26]. Exports accounts for $794.7 million (2017 est.), export commodities are aluminum, electricity, cotton, fruits, vegetable oil, textiles.

With the support of international financial institutions, projects are regularly implemented to introduce a circular economy in various sectors, for example: the agricultural sector, green city management in the energy sectors, transport, waste management, etc.

In particular, the Resource Efficiency in Agri-food Production and Processing (REAP) project in Tajikistan aimes to implementing Sustainable Consumption and Production (SCP) practices micro, small and medium enterprises (MSMEs) in agri-food production and processing sector[27].

An example of introducing a circular economy is the Green City Action Plan (NGAP) for Dushanbe (Tajikistan) in the framework of EBRD's Green Cities Program has a particular focus on waste management and increasing waste recycling and reuse rate.

Statistical data on achievement of SDG 12 indicators are not available[28].

According to the official representative of the National Center for Implementation of Obligations of the Stockholm Convention on Persistent Organic Pollutants under the Committee for Environmental Protection of the Republic of Tajikistan, as of 2023 there are no statistical reports on the generation and collection of plastic waste and plastic bags in Tajikistan[29]. The infrastructure for processing secondary resources is assessed as poorly developed. There are no statistics on the volumes and types of secondary raw materials and their further movement. At the same time, there is a tendency to increase the volume of household waste with minimal involvement in reuse.

24 https://zoinet.org/wp-content/uploads/2018/02/CA-waste-eng.pdf

25 https://stat.gov.kz/ru/industries/environment/stat-eco/publications/68178/

26 https://economy.com/tajikistan/

27 https://www.switch-asia.eu/resource/cleantech-finance-report-tajikistan/

28 https://tajstat.github.io/sdg-site-tajikistan/tg/12/

29 https://vecherka.tj/archives/59418

Case study: Turkmenistan

GDP - composition, by sector of origin: agriculture: 7.5%; industry: 44.9%: services: 47.7% (2017 est.)[30]. Exports: $7.394 billion (2017 est.). Exports - commodities: gas, crude oil, petrochemicals, textiles, cotton fiber. Imports: $4.801 billion (2017 est.). Imports - commodities: machinery and equipment, chemicals, foodstuffs.

Information on the achievement of target indicators for SDG 12 Responsible consumption and production related to waste processing is not available[31].

According to the Central Asia Waste Management Outlook 2019, Turkmenistan's waste generation estimates are about 0.5-1 mln tonnes of municipal solid waste per year and 0.5-1 mln tonnes of industrial waste per year. Recycling rate estimation is about 1 percent. Most recycled waste items and capacities are paper and metals.

Case study: Uzbekistan

GDP - composition, by sector of origin: agriculture: 18.5%; industry: 34.4%; services: 47% (2017 est.) Exports: $11.38 billion (2017 est.). Exports - commodities: energy products, cotton, gold, mineral fertilizers, ferrous and nonferrous metals, textiles, foodstuffs, machinery, automobiles. Import: $11.44 billion (2017 est.). Imports - commodities: machinery and equipment, foodstuffs, chemicals, ferrous and nonferrous metals[32].

Waste management: The statistics for SDG 12 shows that in Uzbekistan 35 million cubic meters of household waste are generated every year. Each citizen of Uzbekistan produces about 165 kg of household waste every year. In the average trash can, about 25% is food waste, 5-10% is paper, 50% is polymers, the rest is metal, textiles, rubber, glass and more. In 2017-2020, the generation of toxic production waste of hazard classes 1-3 per capita increased from 0.7% to 10.6%. In turn, the level of recycling of solid household waste over the same years increased from 9% to 21.9%. The country's solid waste management systems are ill-equipped to meet current demand. Outside the capital, Tashkent, it is a usual practice when collected waste is simply thrown into open dumps outside the populated area[33].

In 2022, the level of processing of generated municipal solid waste was 30%. By 2030, the goal is to achieve a 60% recycling rate[34].

E-waste: According to the Ministry of Ecology, on average more than 140 thousand tons of electronic waste are generated per year in Uzbekistan, or 4-4.5 kg per capita. Most of them are batteries and accumulators, which are located separately or as part of various electrical equipment[35]. With the development of the electronics industry, solar energy sector and green transport, the amount of electronic waste will significantly increase. For

30 https://www.economy.com/turkmenistan/indicators

31 https://sdg.stat.gov.tm/ru/goals/12

32 https://www.economy.com/uzbekistan/indicators

33 https://ns1.stat.uz/goal/15

34 https://lex.uz/ru/docs/6303233

35 https://www.gazeta.uz/ru/2024/02/10/electronic-waste/

instance, imports of electric vehicles in 2023 amounted to 25.7 thousand units. Taking into account the growth in the production and import of electric cars, by 2035 it is expected that about 10 thousand tons of electronic waste will be generated in the form of batteries that have exhausted their service life, the Ministry of Ecology indicated.

The Ministry of Environment notes the following problems associated with the collection and recycling of batteries:

- there is no centralized system for collecting and recycling batteries; they are collected in the general stream of solid household waste and thrown into landfills;
- collection of used batteries is not regulated, the market is unregulated. At the same time, collected batteries are disposed of in illegal ways, in most cases violating the requirements of environmental, labor and health protection laws;
- there is no statistical database on e-waste, including batteries and their types;
- there is no scientific research on the recycling of electronic waste, including batteries.

Environmental impact

All four countries are part of the Paris Agreement and announced their updated nationally determined contributions (NDC) with less or more detailed plans for achievement of the NDCs.

According to the assessments outlined in the World Bank's survey "Net Zero Energy by 2060. Charting the Path of Europe and Central Asia toward a secure and sustainable energy future»[36] (2024), average per capita greenhouse gas (GHG) emissions in the region stand at 11,4 tonnes of CO2 equivalent per capita (tCO2e/capita). This figure is well above the EU average of about 6.97 tCO2e/capita and the world average of 5.94 tCO2e/capita.

Table 6. GHG emissions in Central Asia countries in 2020

Country	***Total emissions (MtCO2e)***	***Percent of world total***	***Total emissions per capita (tCO2e /capita)***	***Status of Country Climate and Development Report***
World	*46,120.92*	*100.0*	*5.94*	
Europe and Central Asia	*4,571.03*	*9.91*	*11.40*	
Kazakhstan	*294.81*	*0.64*	*15.72*	*Published (FY22)*
Tajikistan	*17.69*	*0.04*	*1.85*	*In preparation (FY24)*

36 https://documents.worldbank.org/en/publication/documents-reports/documentdetail/099022124142035945/p17774414c3d1609d1a10c1c69a4e516dd0

Turkmenistan	*194.09*	*0.42*	*32.18*	*Not yet scheduled*
Uzbekistan	*187.52*	*0.41*	*5.48*	*Published (FY23)*

Source: Net Zero Energy by 2060. Charting the Path of Europe and Central Asia Toward a Secure and Sustainable Energy Future, WB 2024.

The survey outlines some important findings on short- and long-term energy and energy security in Europe and Central Asia (ECA). In particular, natural gas and coal subsidies can undermine energy security and decarbonization efforts in Central Asia. Since Central Asia has been a large net exporter of gas, notably to China, rapidly growing demand within the CA countries, combined with stagnating production in Kazakhstan and Uzbekistan, in the short term it faces a tightening gas supply balance and the need to improve regional gas trade.

The survey stresses that a greater investment will be needed to achieve the Net Zero 2060 goal. The total ECA regional investment needed between 2023 and 2060 to achieve the Net Zeto 2060 goal amounts to $4.7 trillion (3.9 percent of regional GDP). The power sector accounts for the largest share of the additional investment needed.

A broader partnership and resource mobilization are needed to implement Nationally Determined Contributions for Kyrgyzstan, Tajikistan and Uzbekistan[37].

As it is outlined in the WB survey, decarbonization is critical to ensuring sustainable growth and energy security while creating new opportunities for green industries and sectors. For instance, calculations show that following the green growth pathway would help Uzbekistan save $67 billion by 2060.

Kazakhstan was a pioneer by putting into effect the Presidential Decree on the Concept of the transition to a green economy and Action Plan in 2013. Kazakhstan has introduced a carbon emissions trading system since 2013. The system covers several industries: production of fertilizers, cement, steel, aluminum, electricity, gas and oil production. Currently, carbon tax is not applied but there is a discussion about introducing it in a view of a wider coverage of economy sectors by carbon emissions regulation. The country uses green taxonomy[38] for classifying green projects eligible for financing through green bonds and green loans.

Also, the country has been so far the first and only one in the CA region setting national net zero target for 2060. Environmental Code[39] (amended in 2024) sets the goals of environmental regulation including ensuring the environmental foundations of sustainable development of the Republic of Kazakhstan and its contribution to strengthening the global response to the threat of climate change in the context of sustainable development. However, the Kazakh economy is one of the most carbon-intensive, with coal power being the backbone of the national energy system[40].

37 https://www.undp.org/sites/g/files/zskgke326/files/2022-09/Проект%20отчета%20о%20рекомендациях.pdf

38 https://adilet.zan.kz/rus/docs/P2100000996

39 https://online.zakon.kz/Document/?doc_id=39768520

40 https://www.kommersant.ru/doc/4966783

Assessments of the implementation of the circular economy have been developed for the city of Almaty in Kazakhstan[41].

Tajikistan adopted the Green Economy Development Strategy for 2023-2037[42]. The revised Nationally Determined Commitments (NDCs) set a target to reduce emissions by 60-70% of the 1990 baseline by 2030. The revised NDC are much higher (35.5 MtCOeq) than the previous estimate (25.5 MtCOeq).

National Strategy for Adaptation to Climate Change until 2030 aims at managing and reducing the risks associated with climate change.

An example of introducing a circular economy is the Green City Action Plan (NGAP) for Dushanbe (Tajikistan) in the framework of EBRD's Green Cities Program to create a green city (including green investments), which provides a systematic and integrated approach to addressing climate change and environmental issues in urban planning and investment in sustainable infrastructure[43].

Each activity contains an estimated carbon reduction. The reduction in carbon emissions as a result of the implementation of the NGAP activities is estimated at 139,732 tCO2e per year, which is a direct contribution to Tajikistan's NDC.

The NGAP contains a number of measures to introduce a circular economy, in particular, the beginning of recycling and reuse of waste from construction and demolition throughout the city.

Turkmenistan has adopted the National Strategy for the Development of Renewable Energy in Turkmenistan until 2030, the State Energy Saving Program for 2018–2024, and Program for the socio-economic development of the country for 2019–2025.

As noted in Turkmenistan's NDC of 2022, the country is implementing the National Climate Change Strategy, where adaptation and mitigation measures occupy a special place[44]. NDC contains a comparatively detailed description of climate finance, but obviously currently most of the funds to finance measures to combat climate change in Turkmenistan are allocated from the state budget.

Uzbekistan adopted The Program for the transition to a Green Economy and Ensuring Green Growth[45] in 2022. The Program contains a number of target indicators such as reduction in GHG emissions per unit of GDP by 35 percent below 2010 level by 2030, expanding the share of renewable energy sources in total electricity production, level of processing of municipal solid waste, etc. According to the World Bank's "Uzbekistan: Country Climate and Development Report" (CCDR Uzbekistan), the country is not yet sending a clear signal about where it is headed in a green transition since there are no targets for methane and nitrous oxide, which account for nearly half of GHG emissions, and the country does not yet have a formal economy-wide net zero target.

41 https://shiftingparadigms.nl/wp-content/uploads/2019/07/Report-Circular-Economy-Almaty-Web-Spread-RUS.pdf

42 https://hlpf.un.org/sites/default/files/vnrs/2023/VNR%202023%20Tajikistan%20Report%20RU.pdf

43 https://ebrdgreencities.com/assets/Uploads/PDF/Dushanbe_GCAP_2022_RUS.pdf?vid=3

44 https://unfccc.int/sites/default/files/NDC/2023-01/NDC_Turkmenistan_12-05-2022_approv.%20by%20Decree_Rus.pdf

45 https://lex.uz/ru/docs/6303233

For the purposes of green finance, in 2023 Uzbekistan adopted the Pilot National Green Taxonomy to be further expanded[46]. In March 2024, for the first time, tentative regulation on the carbon emissions trading system[47] was introduced. According to CCDR Uzbekistan[48], introducing carbon pricing through a carbon tax will also spur the investments needed to reach net zero emissions.

The World Bank's survey "Net Zero Energy by 2060. Charting the Path of Europe and Central Asia Toward a Secure and Sustainable Energy Future" provides an example of possible future development of ammonia production in the frame of circular economy being formed in CA region. The survey says that two percent of global total final energy consumption, and 1.3 percent of CO2 emissions can be attributed to ammonia production. Ammonia is an important export product for several countries in ECA. Uzbekistan is the largest ammonia producer in CA, accounting for nearly 60 percent of ammonia production, followed by Turkmenistan (32 percent) and Kazakhstan (15 percent). Most ammonia capacities in the CA are outdated and need gradual replacement. Green ammonia offers important potential in Central Asia. In the Net Zero 2060 scenario, green ammonia production from solar power becomes cos-competitive with gray ammonia between 2030 and 2035, first in Kazakhstan then in Uzbekistan. From 2035, it also becomes cost competitive with blue ammonia.

Innovation and Investments

The global finance sector is gradually adopting circular economy approaches through various private financial mechanisms, such as circular economy-themed "green bonds", specialized circular economy funds and other financial instruments. A group of international financial institutions have also come together to launch a Circular Economy Finance Roadmap for 2030[49].

According to the Industrial Analytics Platform, investment in the circular economy remains very low and is still considered very high risk. The poor performance of investment funds is another concern. For example, the high-profile BlackRock circular economy fund, launched in 2019, has only generated negative returns since 2021, despite growing to over $1.7 billion in net assets. To put this into perspective, billions are invested annually in circular solutions by the private and public sector, but trillions are invested each year into linear models which continue to be more profitable in financial terms, inhibiting a systemic shift of the economy[50].

Chatham House is a 2021 survey[51] estimated circular economy's share of total global investment at only about 3 per cent per year. This conclusion was made based on the assessment of the current value of government and corporate spending on circular economy initiatives in selected sectors of world economy, and in value chains with high material intensity. Worldwide, public sector spending on the circular economy totalled

46 https://lex.uz/ru/docs/6644013

47 https://lex.uz/ru/docs/6832897

48https://documents.worldbank.org/en/publication/documents-reports/documentdetail/099111423124532434/p1790681e5fb89481911d142b818f571f046c76bbe10

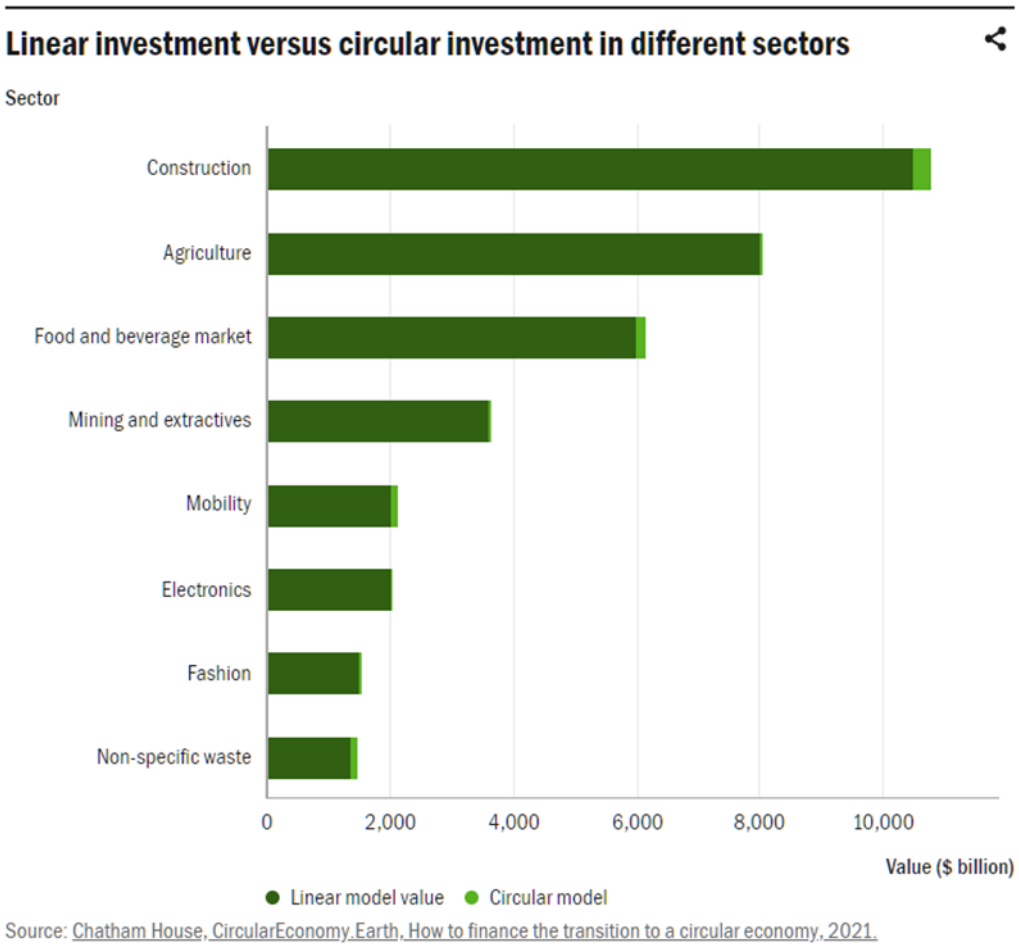
49 https://www.circle-economy.com/resources/roadmap-circular-finance-2030

50 https://iap.unido.org/articles/unlocking-circular-economy-through-green-finance

51 https://www.chathamhouse.org/2021/07/financing-inclusive-circular-economy

between $500 billion and $600 billion in 2020, compared with overall government spending of about $13 trillion. Meanwhile, the value of annual circular economy spending by the corporate sector is estimated at around $850 billion, compared with $35 trillion in linear spending (Figure 4.4).

Figure 7. Linear investment versus circular investment in different sectors of world economy, as of 2021.



Source: https://iap.unido.org/articles/unlocking-circular-economy-through-green-finance

As United Nations' Environmental Program, UNEP outlines in its recommendations for CA countries published in 2021, broader partnerships and resource mobilization are needed to implement Nationally Determined Contributions for Kyrgyzstan, Tajikistan and Uzbekistan[52].

[52]https://www.undp.org/sites/g/files/zskgke326/files/2022-09/Проект%20отчета%20о%20рекомендациях.pdf

In the UNECE review of Uzbekistan "Innovation for Sustainable Development" it is stressed that to sustain growth following recent reforms in Uzbekistan, innovation will be central to tackling structural challenges[53].

The investment in and innovation for the circular economy in Central Asian countries remains significantly low compared to global levels (Table 7). Despite some initiatives and government interest, the scale of investment in circular economy projects is minimal, and the perception of high risk continues to inhibit substantial financial commitment.

Table 7: Innovation and Investment in Circular Economy in Central Asian Countries

Aspect	Kazakhstan	Tajikistan	Turkmenistan	Uzbekistan
Innovation Initiatives	Moderate (waste management, renewable energy)	Low (sustainable agriculture, recycling)	Low (renewable energy, energy efficiency)	Moderate (waste management, sustainable agriculture)
Investment Levels	Low (limited compared to linear investments)	Very Low (minimal circular investments)	Very Low (focus on traditional sectors)	Low (growing interest, early stages)

Kazakhstan shows the most promise with moderate innovation initiatives in waste management and renewable energy but still low investment levels relative to traditional sectors.

Tajikistan and **Turkmenistan** are at the early stages, with very low investment and limited innovation initiatives primarily focused on small-scale projects and traditional sectors.

Uzbekistan is making gradual progress with moderate innovation initiatives in waste management and sustainable agriculture, but investment remains low and primarily in early development stages.

Conclusion

Evaluating the circular economy in Central Asian countries requires a comprehensive approach, as there is no single indicator that can capture the entirety of circularity within a nation. This analysis considers key indicators such as resource productivity, recycling rates, waste generation, and the contribution of circular economy activities to GDP. These

[53]https://unece.org/sites/default/files/2022-06/9789211172966_I4SDR_UZBEKISTAN_2022_web_full%2Bcover.pdf

indicators together offer a holistic view of circularity, reflecting the complex interplay between environmental, economic, and social dimensions inherent in circular economy principles. The multi-indicator approach underscores the need for robust data collection and analysis to effectively assess and track progress in circular economy initiatives.

Kazakhstan and Uzbekistan are at the forefront of circular economy initiatives in the region. Kazakhstan demonstrates leadership in policy and governance, economic performance, and innovation investments. Despite these strengths, Kazakhstan must significantly improve its waste recycling practices to fully capitalize on circular economy benefits. Uzbekistan shows balanced progress across various indicators, with notable achievements in waste recycling, positioning it as a potential model for other Central Asian countries. The country's moderate scores in policy, economic indicators, and innovation reflect a growing commitment to circular economy principles, although further development is needed to sustain this momentum.

In contrast, Turkmenistan and Tajikistan face considerable challenges. Both countries have weaker policy frameworks, lower economic activities related to the circular economy, and minimal innovation efforts. Their waste recycling percentages are notably low, highlighting significant gaps in waste management infrastructure and practices. To catch up with regional leaders, these countries need to strengthen their policy frameworks, enhance economic initiatives, and invest more in circular economy practices. The lack of comprehensive data collection and standardized indicators across all four countries impedes effective policy implementation and progress tracking. Accurate and reliable data are essential for assessing circular economy performance and making informed policy decisions.

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[4] https://www.iso.org/standard/80650.html

[5] https://www.iso.org/standard/82339.html

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[14] https://ec.europa.eu/eurostat/statistics-explained/SEPDF/cache/76074.pdf

[15] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Import

[16]https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Domestic_extraction_(DE)

[17]https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Direct_material_input_(DMI)

[18] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Recycling_of_waste

[19] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Backfilling

[20]https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Domestic_material_consumption_(DMC)

[21] https://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Export

[22] Materials which are dispersed into the environment- with current technology- as a deliberate or unavoidable consequence of product use, for example, mineral fertilisers and abrasion from tyres. See https://ec.europa.eu/eurostat/statistics-explained/SEPDF/cache/76074.pdf

[23] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Incineration

[24] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Landfill

[25] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Recovery_of_waste

[26] https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32008L0098

[27] https://eur-lex.europa.eu/legal-content/en/ALL/?uri=CELEX%3A31994L0062

[28] https://eur-lex.europa.eu/legal-content/en/ALL/?uri=CELEX%3A32002L0096

[29] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Recovery_of_waste

[30] https://ec.europa.eu/eurostat/statistics-explained/SEPDF/cache/76074.pdf

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[63] https://www.economy.com/uzbekistan/indicators

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[66] https://www.gazeta.uz/ru/2024/02/10/electronic-waste/

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NET ZERO ENERGY BY 2060 Charting the Path of Europe and Central Asia Toward a Secure and Sustainable Energy Future, 2024

3. National Policies for Circular Economy in Central Asia

Evaluating Circular Economy Policies and Regulations in Central Asia

The transition towards a Circular Economy (CE) is rapidly accelerating within the policy frameworks of numerous nations. Notably, the European Commission has spearheaded this shift by formulating a strategic agenda aimed at transforming the European Union's economy into one that is circular in nature. This initiative commenced with the CE Action Plan in 2015, followed by the introduction of a new CE Action Plan in 2020. The latter serves as a cornerstone of the European Green Deal, underlining the EU's commitment to sustainable economic practices.

The CE is a modern approach to sustainable development that aims to minimize waste and make optimal use of resources through reuse, recycling and recovery. In the context of global environmental challenges associated with climate change and depletion of natural resources, the transition to a digital economy is becoming increasingly urgent.

Central Asian countries have demonstrated a strong commitment to CE principles through legislation, policy documents and incentive measures. These efforts are aimed at ensuring sustainable development, efficient use of natural resources and reducing negative impacts on the environment.

Kazakhstan, striving for sustainable development and improving the quality of life of the population, is actively implementing the principles of CE. Kazakhstan has developed a strong legislative framework to support the development of a CE. The main laws and strategic documents governing environmental protection and rational use of natural resources include on the **Table** :

Table 8: Environmental Laws in Kazakhstan

Law/Code	Year	Description
Law "On Environmental Protection"	1997	Main legal act regulating environmental protection in Kazakhstan.
Law "On Radiation Safety"	1998	Regulates radiation safety and radioactive waste management.
Law on Waste Management	2022	Defines norms and standards for waste management.
Water Code	2003	Standards for water resource management and protection.
Environmental Code	2021	Comprehensive document on environmental protection and sustainable use.
Law "On Renewable Energy Sources"	2009	Stimulates the use of renewable energy sources.
Law "On Nuclear Energy"	1997	Regulates nuclear energy use and safety.
Law "On the production of organic products"	2015	Regulates the production and turnover of organic products.
Law “On Energy Saving and Energy Efficiency”	2012	Regulates public relations and determines legal, economic and organizational grounds of activity of individuals and legal entities in the field of energy saving and increase of energy efficiency.

Table 9: Strategic Documents and Initiatives in Kazakhstan

Concept/Program	Year	Description
Concept for Transition to a "Green" Economy**[1]**	2013	Foundation for systemic transformations in the economy.
Program for Agro-Industrial Complex Development**[2]**	2013-2020, 2021-2025	Development of agriculture with sustainable principles.
State Program for Accelerated Industrial Development**[3]**	2010-2025	Stimulate industrial growth with eco-friendly technologies.
State Program for Education Development	2011-2025	Improvement of the education system focusing on environmental education.
Industry Program "Zhasyl Damu"**[4]**	2010-2014	Focus on environmentally sustainable development.

Almaty, the largest city in Kazakhstan, has become a pioneer in introducing CE principles to the region. The city is actively mapping resource consumption and developing new strategies for its efficient use. Composting and closed-cycle agriculture technologies are being introduced in Almaty. This helps reduce organic waste and improve soil quality, which promotes sustainable agriculture. The city is developing the processing and disposal of industrial waste. Introducing mandatory recycling standards for certain industries helps reduce waste and reuse materials. Almaty's construction industry uses circular strategies, including the use of recycled or renewable materials. This helps reduce the burden on the environment and improve the environmental situation in the city.

Table 10: Kazakhstan identifies several key areas for the transition to a CE:

Energy	Kazakhstan is seeking to reduce its dependence on coal, gradually moving towards the use of natural gas and renewable energy sources such as solar and wind power. This will reduce greenhouse gas emissions and improve the environmental situation in the country.
Agriculture	Incorporating circular technologies into agriculture includes composting, optimizing water use and crop rotation. This will help improve soil fertility, reduce the use of chemical fertilizers and minimize the negative impact on the environment.
Industrial production	Kazakhstan is actively developing waste processing and disposal. Legislation sets mandatory standards for certain waste recycling industries to help reduce waste and reuse materials.

Construction	The construction industry is implementing circular strategies that focus on using recycled or renewable materials. This includes recycling construction waste and using environmentally friendly technologies.

To promote the CE, the government of Kazakhstan provides various benefits and incentives like tax benefits, subsidies and grants, mandatory waste recycling and investment incentives.

Table 11: Government Incentives for CE in Kazakhstan

Incentive	Description
Tax Benefits	Tax reductions for companies implementing waste recycling and renewable energy technologies.
Subsidies and grants	Financial support for renewable energy and waste recycling projects.
Mandatory waste recycling	Establishment of mandatory standards for certain waste recycling industries.
Investment Incentives	Preferences for investors in green energy and environmental technology projects, including tax incentives, subsidies, and other supports.

Despite significant progress, Kazakhstan faces a number of challenges on the way to fully implementing the principles of a CE. Despite the active development of renewable energy sources, coal still plays an important role in the country's energy balance. The transition to alternative energy sources requires significant investment and time.

In this context, **Turkmenistan** is taking active measures to develop a CE aimed at the efficient use of resources, waste reduction and environmental conservation. The legislation of Turkmenistan on the development of the CE includes in the **Table** below.

Table 12: Environmental Laws in Turkmenistan

Law/Code	Year	Description
Law “On Nature Protection”	2014	Legal basis for nature conservation and rational use.
Air Protection Law	1996	Measures to prevent air pollution.
Sanitary Code of Turkmenistan	2009	Standards for environmental protection and population safety.
Law on Radiation Safety	2009	Regulation of radiation safety.
Law on Chemical Safety	2011	Regulation of chemical safety.

Law "On Hydrocarbon Resources"	2008	Use and rational development of hydrocarbon resources.
Law "On Environmental Expertise"	2014	Procedure for environmental expertise to assess activity impacts.
Law "On Licensing of Certain Types of Activities"	2009	Licensing of activities with environmental impact.
Waste Law	2015	Strategic directions for waste management, including recycling prioritization.

Additional measures have also been taken to improve measures for the CE. Regulations on State Environmental Expertise, approved by the President (1996) and establishes the procedure for conducting state environmental expertise to assess the impact of proposed activities on the environment. Also, National Oil Spill Prevention and Response Plan (2001) defines oil spill prevention and response measures that are essential to preventing environmental pollution. "Sustainable Cities in Turkmenistan: Integrated Green Urban Development in Ashgabat and Awaza" (2016) project aims at improving urban lighting systems, increasing energy efficiency, introducing sustainable transport solutions and reducing waste citywide.

As for **Tajikistan**, the CE is becoming increasingly relevant, given the need to balance economic growth with environmental protection and rational use of resources. The main laws and regulations adopted are presented below.

Table 13: Environmental Laws in Tajikistan

Law	Year	Description
Law "On production and consumption waste"	2002	Regulates waste management to minimize and recycle materials.
Law "On Radioactive Waste Management"	2013	Prevents negative impacts of radioactive waste on environment and health.
Law "On Environmental Information"	2011	Defines procedure for providing environmental information to the public.
Law "On Environmental Protection"	2011	Ensures sustainable development and environmental protection.

Table 14: What seem to be strategies and concepts related to the CE in Tajikistan:

Strategy/Concept	Year	Description
Concept of Environmental Protection	2008	Defines the main directions of state policy in the field of environmental protection, including the development of a CE.
Strategy for the Development of the Green Economy	2022	Aimed at developing an economy using renewable energy sources and reducing the carbon footprint, which is consistent with the principles of a CE.
Concept of the Transition to Sustainable Development	2007	Includes measures for the sustainable use of resources and the development of environmentally sustainable processes, which is consistent with the principles of a CE.

As all Central Asian countries, **Uzbekistan** is actively developing strategies and activities aimed at introducing the principles of a CE. The country's legislative framework plays an important role in this process, providing a legal basis for reforms and regulation of activities in the field of resource and waste management.

Table 15 is summarizing the legislative acts and regulations related to the CE in Uzbekistan:

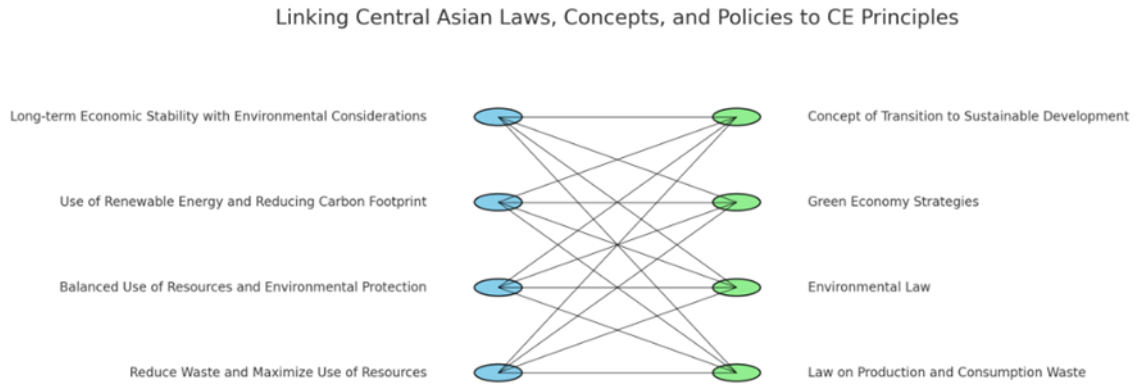
Law/Decree	Year	Description
Law “On Waste”	2002	Defines the basic norms and rules for waste management.
Resolution "On measures to further improve the efficiency of work in the field of household waste management"	2014	Establishes the procedure for state accounting and control in the field of waste management.
Decree “On measures to further improve the household waste management system”	2017	Determines the strategic directions for the development of the waste management system.
Decree “On measures for radical improvement and development of the waste management system for 2017-2021”	2018	Contains measures to improve the efficiency of work with household waste.
Resolution “On approval of the Regulations on the procedure for state accounting and control in the field of waste management”	2018	Establishes additional measures to improve the household waste management system.

The Solid Waste Management Strategy for 2019-2028	2019	Defines the strategic directions of work on household waste management.
Resolution "On measures to improve activities in the field of management of household and construction waste in the city of Tashkent"	2020	Contains measures to improve activities in the field of management of household and construction waste in Tashkent.
Decree “On priority measures to reform the waste management system”	2022	Defines priority measures to reform the waste management system.

The most important thing to note is the adoption of the Strategy for the Transition to a Green Economy for the period 2019-2030 (2019) which includes provisions on energy efficiency, renewable energy development, clean transport, water and waste management, as well as forest restoration and financial mechanisms to support a green economy. Projects and initiatives were also adopted, such as "Ecotrans", is a bicycle rental service where consumers can use a dedicated app for payment and security; and "Green Roofs". The project is aimed at greening roofs, creating recreational and sports areas on the roofs of residential buildings and business centers.

Central Asia countries demonstrate a serious commitment to implementing CE principles through a comprehensive legislative framework, strategic documents and incentive measures. These efforts are aimed at ensuring sustainable development, rational use of natural resources and reducing negative impacts on the environment. Almaty, being a leader in Central Asia in implementing CE principles, creates the basis for a sustainable future and serves as an example for other countries in the region.

Figure 8: Linking Central Asian Laws, Concepts, and Policies to CE Principles



Source: Own elaboration

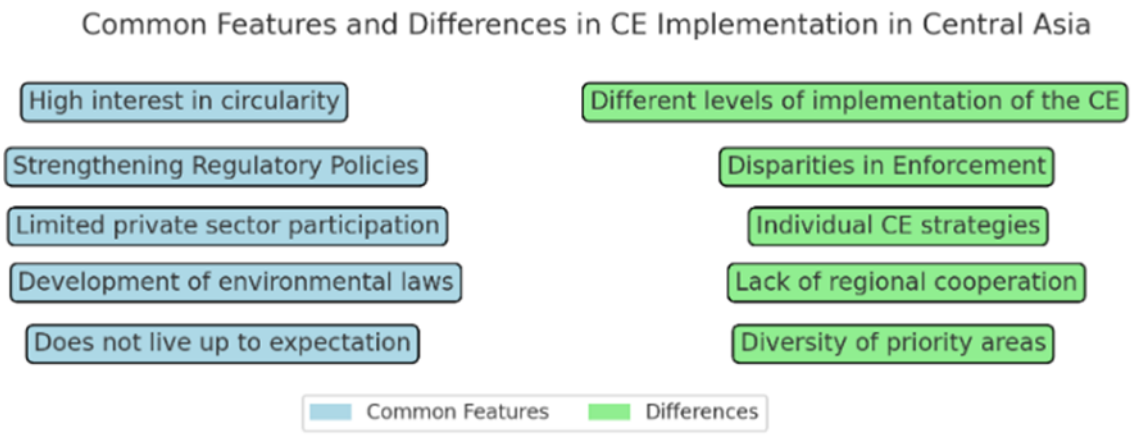
By linking these laws, concepts and policies to the principles of a CE, the region can develop sustainable consumption and production patterns, reducing its environmental burden and creating new opportunities for economic growth.

As a result, Central Asia is making strides towards integrating CE principles into its development strategies, albeit with challenges and opportunities that vary across the region. Almaty (Kazakhstan) has emerged as a pioneer by identifying CE opportunities, marking a significant step for Central Asia. The city has engaged in mapping resource consumption to devise new CE strategies, aiming to bolster its sustainable development ambitions. This initiative includes agricultural enhancements, like composting and closed-cycle farming, and industrial strategies, such as waste recycling and remanufacturing. Construction practices are also being revised to incorporate circular strategies, focusing on using materials of secondary or renewable origin.

However, the region faces several barriers to fully implementing CE principles. Central Asia's heavy reliance on rainfall for agriculture, coupled with inefficient water management, poses a significant threat to food security in the event of droughts. There's also a noted dependency on conventional energy sources, with renewable energy making up a minor proportion of the total energy consumed, except in Tajikistan, which shows a higher utilization of renewable resources. The region grapples with poor waste management practices and the challenge of transitioning agriculture towards circularity.

After conducting the analysis, one can notice that, despite the general interest in this region, there are noticeable differences in the level of implementation and approaches to CE.

Figure 9: Common Features and Differences in CE Implementation in CA



Source: Own elaboration

This analysis highlights the importance of further development and coordination of efforts in implementing the CE in Central Asian countries.

Benefits and Tax Incentives for Circular Economy Initiatives

The incentives to circular economy transition include tax reductions, subsidies, grants, and regulatory measures aimed at encouraging waste recycling, renewable energy adoption, and sustainable practices. Kazakhstan and Uzbekistan offer tax benefits, financial support, and mandatory recycling standards, while Turkmenistan focuses on government regulations and state programs. Tajikistan provides financial incentives and public awareness programs to promote circular economy principles. Despite these efforts, the current incentives are not sufficient to drive a comprehensive transition to a circular economy. The low recycling rates in Kazakhstan, the reliance on conventional energy sources in Uzbekistan, the inadequate enforcement of environmental regulations in Turkmenistan, and the underdeveloped waste management infrastructure in Tajikistan highlight significant gaps.

Table 16: Summary of Benefits and Tax Incentives

Country	Benefit/Tax Incentive	Description	Examples
Kazakhstan	Tax Reductions	Reduced tax rates for companies implementing waste recycling and renewable energy technologies.	A company installing solar panels may receive a significant tax reduction on their income tax.
	Subsidies and Grants	Financial support for projects in renewable energy and waste recycling.	Grants for developing a new recycling plant or subsidies for wind energy projects.
	Mandatory Waste Recycling	Establishing mandatory standards for waste recycling in certain industries.	Industries required to segregate and recycle waste, reducing landfill usage.
	Investment Incentives	Preferences for investors in green energy and environmental technology projects.	Tax incentives for investors funding renewable energy startups.
Uzbekistan	Tax Reductions	Tax reductions for waste processing and recycling companies.	Recycling companies receive reduced corporate tax rates.

	Financial Support	Subsidies, soft loans, and grants for sustainable resource and waste management projects.	Grants for startups focusing on eco-friendly product designs.
	Mandatory Standards	Regulations requiring recycling and use of secondary resources in certain industries.	Manufacturing industries mandated to use a percentage of recycled materials in production.
	Government Procurement Preferences	Preference for circular production methods in government procurement.	Government contracts awarded to companies with sustainable practices.
Turkmenistan	Government Regulations	Policies to prevent air and water pollution and manage chemical and radiation safety.	Regulations enforcing reduced emissions for factories.
	State Programs	Financial and technical support for renewable energy and waste management projects.	Subsidized loans for companies adopting green technologies.
	Incentives for Private Sector Engagement	Encouragement of private sector involvement in circular economy initiatives.	Tax breaks for businesses that implement energy-saving measures.
Tajikistan	Financial Incentives	Grants and subsidies for companies undertaking sustainable projects.	Subsidies for farms using organic farming techniques.
	Regulatory Measures	Policies supporting recycling and waste management.	Mandatory recycling programs for urban areas.
	Public Awareness Programs	Programs to increase awareness and competence in circular economy practices.	Educational campaigns promoting the benefits of recycling.

Source: Own elaboration

Kazakhstan has established a comprehensive legislative framework to support circular economy principles, including key laws on environmental protection, radiation safety, waste management, and renewable energy. The "Concept for the Transition to a Green Economy" is a pivotal document that guides these efforts, emphasizing resource efficiency, modernization of infrastructure, public well-being, and national security. Strategic programs such as the State Program for Accelerated Industrial and Innovative Development and the Industry Program "Zhasyl Damu" support industrial growth and environmental sustainability. **Notably, Kazakhstan is investing in renewable energy projects and enhancing its waste management systems.** Despite these efforts, **Kazakhstan still heavily relies on coal, and the recycling rates remain low, indicating a gap between policy and implementation.**

Uzbekistan has made progress in developing its legislative framework, including laws on waste management, household waste efficiency, and green economy strategies. The country focuses on improving waste management, energy efficiency, sustainable transport, and construction practices. Significant initiatives include reforestation projects and enhanced water management. **Uzbekistan is also implementing programs to reduce greenhouse gas emissions and improve public awareness of environmental issues.** However, Uzbekistan **faces challenges in advancing circular practices in agriculture**, enforcing waste management policies, and increasing renewable energy adoption.

Turkmenistan's legislation emphasizes nature protection, air protection, radiation and chemical safety, hydrocarbon resources, and waste management. State programs aim to improve **energy efficiency, promote renewable energy**, and reduce environmental pollution. Initiatives such as the "Sustainable Cities in Turkmenistan" project highlight urban sustainability efforts. **Efforts are also being made to integrate environmental education into the national curriculum and to develop public-private partnerships for environmental projects.** However, Turkmenistan must strengthen the enforcement of environmental regulations, **develop comprehensive waste management infrastructure, and encourage private sector participation in CE initiatives**. Increasing public awareness and understanding of sustainable practices is also crucial for policy implementation. By focusing on energy efficiency across sectors and promoting the reuse and **recycling of water and textiles,** Turkmenistan can make significant strides in its circular economy transition.

Tajikistan's legislation covers production and consumption waste, radioactive waste management, environmental information, and protection. Strategic documents focus on green economy development and sustainable development, emphasizing resource efficiency, waste reduction, and environmental protection. **The country faces critical challenges in building infrastructure for waste management and recycling,**

enhancing its regulatory framework, and investing in modern technologies for waste processing. Tajikistan is also working on improving cross-border environmental cooperation and engaging international organizations in its circular economy initiatives. Public education on circular economy benefits and practices is essential to increase community involvement and support. **By targeting agricultural sustainability through organic farming and efficient water use**, and establishing community-based recycling programs, Tajikistan can leverage its strengths and address its unique challenges in transitioning to a circular economy.

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[1] The key strategic document is the Concept for the transition of the Republic of Kazakhstan to a "green" economy dated May 30, 2013, No. 577. This document lays the foundation for deep systemic transformations in the economy. Main tasks include improving the efficiency of resource use (water, land, biological, etc.) and their management; modernization of existing and construction of new infrastructure; improving public well-being and environmental quality; enhancing national security, including water security.

[2] The agro-industrial complex for 2013–2020 ("Agribusiness-2020") and for 2021–2025. The main direction is the development of agriculture taking into account the principles of sustainable development. The program aims to increase resource efficiency, improve land and water management, and introduce advanced agricultural technologies.

[3] The goal is to stimulate industrial and innovative growth, including the development of environmentally friendly technologies. The program supports the development of new industrial projects, the creation of innovative enterprises and the introduction of advanced technologies into production.

[4] The program is aimed at improving air quality, managing production and consumption waste, combating desertification and land degradation, increasing soil fertility, and developing fisheries and aquaculture.

4. Circular economy and sustainability in a higher education institutions

CE education in Central Asia

Currently, the topics of circular economy and sustainable development are underrepresented in the education system of Kazakhstan, Tajikistan, Turkmenistan and Uzbekistan.

Kazakhstan. 39 universities in Kazakhstan graduate specialists with the qualification "Ecology". Educational programs presented at universities in Kazakhstan are mainly of a traditional nature: "Life safety and environmental protection", "Natural and man-made risks", "Ecology" (see Table 17). Only a few universities are introducing new educational programs, the content of which reflects the essence of the circular economy: "Innovative management of the safety of natural and man-made emergencies", "Medical engineering", "Precision agriculture". The educational process also includes disciplines filled with ideas of sustainable development: "Renewable energy", "Restoration of rivers and reservoirs", "Geo-ecological assessment of land", "State control over the use and protection of land", "Climate change and green economy", "Engineering and environmental safety in construction", "Innovative and urban landscape

design systems", "Innovative technologies for processing raw materials of ferrous and non-ferrous metallurgy" and others.

Table 17. Graduates of specialists from higher educational institutions in environmental specialties (https://stat.gov.kz/ru/).

Speciality	2020	2021	2022
Ecology	897	705	711
Life safety and environmental protection	1 483	1 183	1 022
Water resources and water use	275	287	220
Land management	235	220	229
Forest resources and silviculture	290	502	316
Total graduates in environmental specialties	3 180	2 897	2 498
Share of graduates in environmental specialties in the total number of graduates of higher educational institutions	2,1	1,9	1,5
Graduation of students from higher educational institutions	153 627	151 679	161 974

The decrease in the number of graduates in environmental specialties in Kazakhstan from 2020 to 2022 can be attributed to several specific factors related to the country's unique context. These factors may include:

Economic Conditions. Oil and Gas Industry Dominance: Kazakhstan's economy heavily relies on the oil and gas sector, which might offer more lucrative career opportunities compared to environmental fields. This economic structure can influence students to pursue studies and careers in industries perceived as more financially rewarding.

Economic Uncertainty: Economic fluctuations and uncertainties can lead students to prioritize fields with more stable job prospects, potentially reducing interest in environmental specialties.

Educational System and Policy. There may be insufficient funding and resources allocated to environmental education programs. Limited financial support can affect the quality and attractiveness of these programs. The curriculum might not adequately emphasize the importance of environmental protection and sustainability. Additionally, there might be a lack of awareness and promotion of career opportunities in these fields among students.

Perception of Environmental Careers. Job Market Perceptions: If the job market for environmental professionals is perceived as limited or unstable, students might opt for fields with clearer career paths and better job security. The societal value placed on environmental careers might be lower compared to other professions. This can impact students' decisions to pursue environmental studies.

Cultural and Social Factors. Cultural and social influences might steer students toward traditional and well-established career paths, such as engineering, medicine, or business, rather than newer or less conventional fields like environmental specialties.

Awareness and Advocacy. There might be a lack of strong advocacy and public awareness campaigns highlighting the significance of environmental issues and the role of environmental professionals.

The decline in the number of graduates in environmental specialties in Kazakhstan from 2020 to 2022 is likely due to a combination of economic conditions, educational policy and funding issues, job market perceptions, and cultural factors. Addressing this trend requires a multifaceted approach, including improving funding and resources for environmental programs, enhancing the curriculum, raising awareness about the importance of environmental protection, and promoting the value and opportunities in environmental careers.

It should be noted that the government of Kazakhstan allocates significant funds for the development of ideas of sustainable development and circular economy. Thus, as part of the financing of scientific and scientific-technical projects on the "green economy" within the framework of grant and program-targeted financing, in 2020, 163,998.4 tenge were allocated for the implementation of 7 projects, in 2021, 175,215.8 tenge for the implementation of 3 projects, in 2022 221,931.8 tenge for the implementation of 6 projects.

Over three years, there has been a marked increase in the total amount of funding allocated to green economy projects, reflecting a growing commitment to environmental research and sustainable development.

However, despite the allocation of significant funds and a growing number of projects, research output is more focused on theoretical advances rather than practical applications and innovations leading to patents. It is necessary to balance theoretical research with practical, applied projects to achieve tangible environmental and energy results. efficiency results (see Table 18).

Table 18. Number of issued patents in the field of environmental protection (https://stat.gov.kz/ru/).

Indicator	2020	2021	2022
Total number of patents issued	1 816	1 773	1 449
of them			
number of patents issued in the field of environmental protection and energy efficiency	110	142	166
Including			
on energy technologies	58	65	63
including those related to renewable energy sources	13	19	28
on environmental technologies	52	77	103

The number of patents issued in energy technologies shows a slight increase, overall, the trend indicates a stable interest and activity in energy technology innovations, with a slight fluctuation in numbers.

The number of patents related to renewable energy sources has shown a significant and consistent increase each year. This trend reflects a growing emphasis on renewable energy innovations.

The number of patents issued in environmental technologies has shown a steady and significant increase each year. The number of patents grew from 52 in 2020 to 77 in

2021, marking an increase of 25 patents (approximately 48%). From 2021 to 2022, the number of patents increased further to 103, an additional 26 patents (approximately 34%).

The consistent increase in the number of patents indicates a growing focus on environmental technologies. This trend suggests that there is increasing research and innovation activity aimed at addressing environmental challenges and improving sustainability practices.

The trend might also reflect the impact of increased funding and support for environmental research and technologies. As more resources are allocated to the green economy and environmental protection, it is likely to result in more innovative solutions being developed and patented.

The rising number of patents in the field of environmental protection and energy efficiency could be a response to both global environmental challenges, such as climate change, and local issues, such as pollution and resource management. This indicates a proactive approach in developing new technologies to mitigate these problems.

The data shows a clear and positive trend in the number of patents from 2020 to 2022. This increase highlights a growing emphasis on research and innovation in this critical area, driven by increased funding, policy support, and the need to address pressing environmental issues. The steady rise in patents suggests that efforts to enhance environmental protection and energy efficiency are yielding tangible results, contributing to the development of sustainable technologies.

Tajikistan. The environmental education system is an integral part of the unified educational system of the Republic of Tajikistan. It is a set of interrelated state educational standards, educational programs of various levels and orientations, ensuring educational continuity of training and the activities of educational institutions and educational authorities.

The following regulatory documents regulating environmental education in Tajikistan can be named: Law of the Republic of Tajikistan “On Environmental Education of the Population”; State comprehensive program for the development of environmental education and education of the population of the Republic of Tajikistan; National Development Strategy of the Republic of Tajikistan for the period until 2030; - Concept of the transition of the Republic of Tajikistan to sustainable development, etc.

The teaching of environmental subjects at all levels of the education system is carried out in accordance with state educational standards (Khakdod at all, 2021).

The topics of circular economy and sustainable development are not universally included in teaching materials and programs. Academic disciplines provide scattered data on environmental issues, which cannot contribute to the formation of current ideas about the modern ecological picture of the world. Disciplines of environmental content are studied in isolation from the practical component, lack an integrated and systematic approach, and are purely educational and ideological in nature. Another important problem of environmental education in Tajikistan is the insufficiently high level of environmental knowledge of practical teachers and information technologies in the learning process (Amirova, 2023; Karimov, 2018; Kholnazarov, 2011).

There are 39 universities and 70 colleges in Tajikistan. Educational programs “Life Safety” and “Ecology” are presented in specialized and technical educational institutions.

Turkmenistan. Currently, there are 26 higher and 45 secondary vocational educational institutions operating in Turkmenistan. In the education system of Turkmenistan, as well as in other countries of Central Asia, components of sustainable

development are being introduced into existing subjects and disciplines: biology, chemistry, botany, geography, and the fundamentals of ecology. An interdisciplinary approach is not used at the current stage in the education system in secondary and higher educational institutions; each discipline is a separate line and is not interconnected with others. Some universities in Turkmenistan have departments of ecology, and such disciplines as "Nature Conservation", "Economics of Environmental Management", "Ecology and Rational Use of Natural Resources", etc. have been introduced into the educational process. (Review of best practices in education for sustainable development in Central Asia in the light of the implementation of the UN Decade for ESD and the UNECE Strategy for ESD (Almaty, 2009).

Uzbekistan. According to Article 4 of the Law of the Republic of Uzbekistan "On Nature Conservation", the main goal of environmental education in Uzbekistan is the formation of a conscious attitude to environmental problems among all segments of the population, including students of secondary schools and colleges, and university students.

Uzbekistan is aware of the problem of the quality and content of such education. State educational standards and curricula do not contain a practice-oriented component and are not consistent with the real problems of the country and the demands of industry and the economy. There is no proper educational and methodological base for circular economy in education (Aimbetova, 2020; Kosimova, 2018).

To effectively solve the country's environmental problems and to introduce innovative ideas, practices and technologies into the realization of the scientific and intellectual potential of Uzbekistan, the Central Asian University of Environmental Studies and Climate Change Green University was created in Uzbekistan in 2023. The university will provide courses on the circular and green economy, sustainable development both for its students and for specialists, scientists, business managers, and entrepreneurs. It is also planned to conduct scientific research capable of solving important environmental, socio-economic and scientific-technical problems of Uzbekistan and Central Asia.

"Environmental expenditures are generally showing an upward trend but remain small. On average, they ac-counted for only 0.06% of total government expendi-tures or 0.02% of GDP over more than the past ten years. The state budget's share of environmental tax revenues remained constant at a 0.01% average between 2015 and 2018. Solid waste collection fees make up 57% of environmental tax revenues. Despite the lack of sys-tematic accounting of all environment-related taxes, environmental revenues from pollution fees, including solid waste and wastewater collection fees, have in-creased. They were almost four times higher in 2018 than in 2010, amounting to around USD 1.7 million. Energy subsidies are gradually declining but remain high. In 2020, fossil fuel subsidies were 60% lower than in 2010 but amounted to almost USD 4 billion (USD 1 = UZS 10 065 in 2020), making up the equivalent of 6.6% of GDP" (Asfaw E.B. and Mirkasimov, 2024).

In conclusion, the current state of environmental education in Central Asia, encompassing Kazakhstan, Tajikistan, Turkmenistan, and Uzbekistan, reveals both challenges and opportunities for integrating circular economy principles and sustainable development goals. While efforts are underway in some countries to introduce relevant disciplines and educational programs, such **initiatives remain sporadic and often disconnected from practical applications**. **There is a notable lack of interdisciplinary approaches and practical components in the curriculum across the region.**

Kazakhstan demonstrates progress with the introduction of new educational programs focused on renewable energy, environmental safety, and green economy. However, the majority of educational efforts in Tajikistan, Turkmenistan, and Uzbekistan are hindered by outdated curricula and insufficient practical training. In Uzbekistan, the recent establishment of the Central Asian University of Environmental Studies and Climate Change Green University signifies a step towards addressing these shortcomings, aiming to educate a new generation of specialists equipped with knowledge in circular and green economy practices.

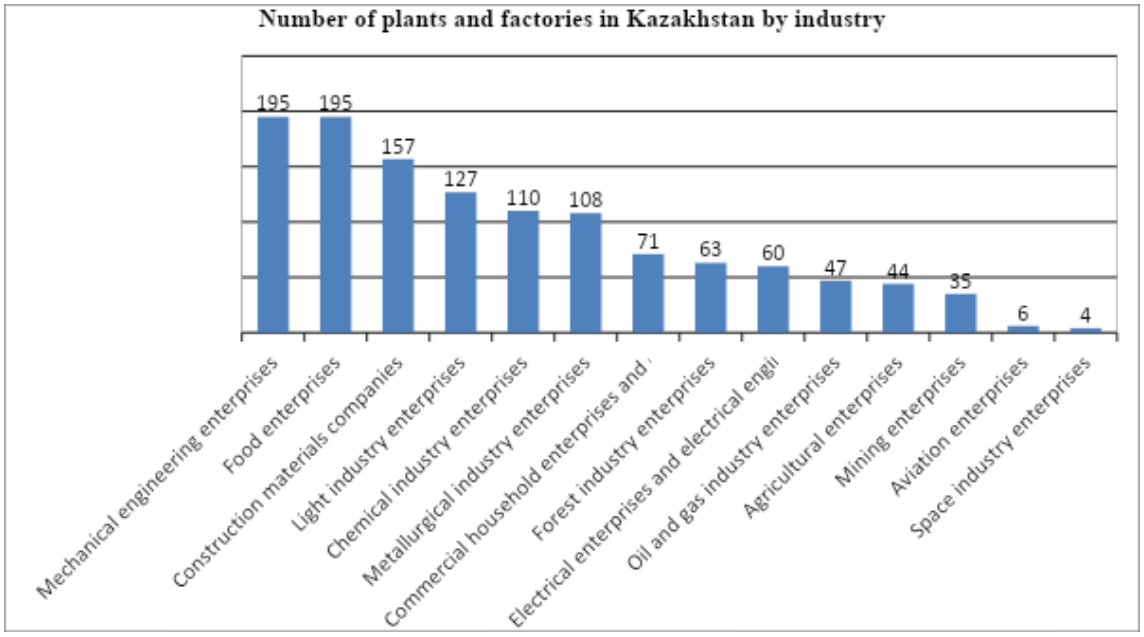
To effectively address environmental challenges and advance sustainable development in the region, it is crucial to overhaul existing educational frameworks. This transformation should prioritize interdisciplinary education that integrates practical applications of circular economy principles. By doing so, Central Asian countries can foster a generation of professionals capable of implementing sustainable solutions across various sectors, thereby contributing to environmental stewardship and societal resilience in the face of global challenges.

Future Labor Market Demand for Circular Economy Skills in Central Asia

In Central Asia, including Kazakhstan, Tajikistan, Turkmenistan, and Uzbekistan, the demand for CE-related skills is expected to rise as these countries work to align their economic practices with global sustainability goals. The region is currently experiencing a gradual integration of circular economy principles into various sectors, including agriculture, industry, and energy (UNEP, 2020; World Bank, 2021). However, the labor market is still in the early stages of adapting to these new demands, and there is a pressing need for a workforce skilled in CE practices.

The structure of the economy of **Kazakhstan** is largely export-oriented. Manufacturing of goods contributes almost 40% of GDP, including 14.5% from mining and 13.2% from manufacturing. Oil and gas production accounts for 80% of the mining sector. Kazakhstan is the world leader in uranium mining: the country produces 33% of the world's volume of this mineral. The manufacturing industry of Kazakhstan is 44% metallurgical production, 15% mechanical engineering and 5.5% production of non-metallic mineral products. The largest private companies in Kazakhstan are mainly engaged in mining. Statistics on the number of plants and factories in Kazakhstan demonstrate the level of industrial development (see Figure 10).

Figure 10. Plants and factories in Kazakhstan by industry. The figure was created based on website materials: https://factories.kz/; https://stat.gov.kz/ru/



Source: Own elaboration

Kazakhstan's economic structure and its reliance on resource-intensive industries highlight the pressing need for circular economy skills. By focusing on resource efficiency, sustainable manufacturing, energy management, and innovative recycling practices, Kazakhstan can better align its industrial activities with global sustainability goals and drive significant improvements in environmental and economic resilience.

Table 19. Number of enterprises with environmental innovations (https://stat.gov.kz/ru/).

Indicator	Unit measurements	2020	2021	2022
Number of enterprises with environmental innovations	Unit	65	88	97
Level of activity in environmental innovation	Percent	0,2	0,3	0,3
Share of environmental innovations in total innovations	Percent	2,0	3,0	3,0

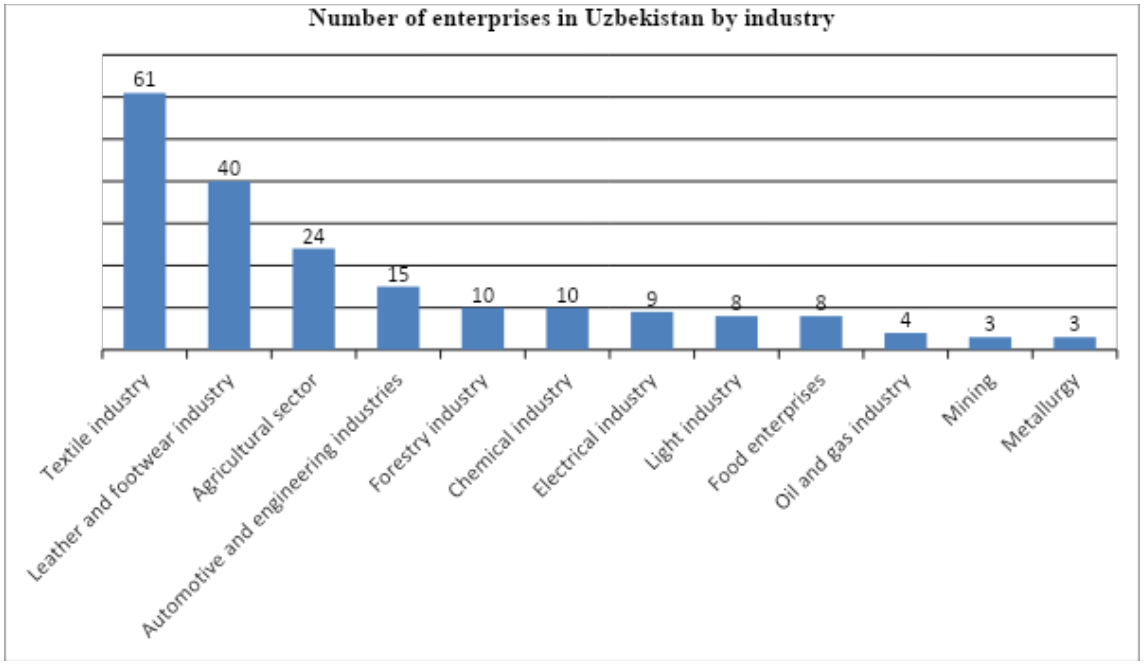
Despite Kazakhstan's burgeoning industrial sector and its substantial focus on resource extraction and manufacturing, the level of engagement in environmental innovation remains relatively low when compared to the overall number of enterprises and innovations in the country (Table 19). As highlighted by recent data, the number of enterprises actively involved in environmental innovations is modest and does not fully reflect the scale of industrial activity or the broader innovation landscape in Kazakhstan. The number of enterprises engaged in environmental innovations has increased from 65 in 2020 to 97 in 2022. However, this growth represents only a small fraction of the total number of plants and factories in Kazakhstan, indicating a limited penetration of

environmental innovation across the industrial sector. The proportion of environmental innovations relative to all innovations has also shown limited growth.

The transition to a circular economy necessitates a profound shift in the workforce towards roles that focus on environmental impact reduction and efficiency optimization. **In Kazakhstan, this means fostering skills in advanced materials science, environmental engineering, and life-cycle assessment.** Professionals will need to be adept at employing innovative technologies for waste management and resource recovery, such as energy-efficient recycling methods and sustainable production practices. Moreover, with Kazakhstan's significant steel and metallurgy sectors, there is an emerging need for experts in **green metallurgy** and the development of less resource-intensive production techniques.

The industry of **Uzbekistan** is aimed at developing import-substituting industries. Currently, various types of products are being produced that were previously imported from other countries. In terms of industrial output, the largest are the fuel and energy, light and food industries. A certain volume of production is provided by the building materials industry, woodworking and pulp and paper industries. Some figures are presented in Figure 11.

Figure 11. Enterprises of Uzbekistan by industry.



Source: Own elaboration

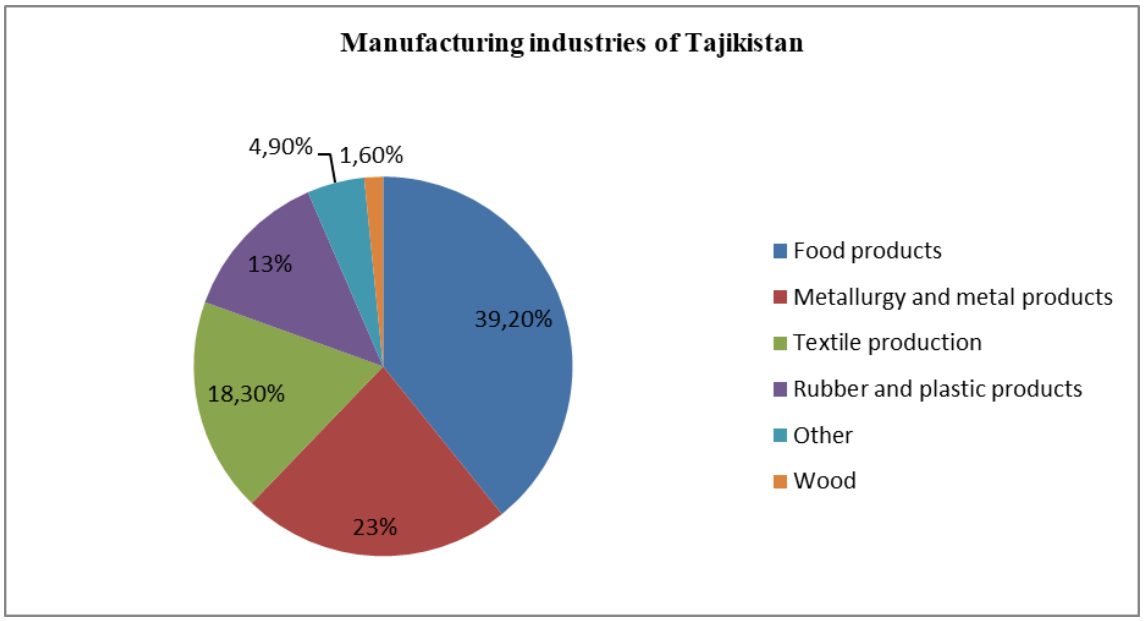
Uzbekistan's substantial agricultural sector plays a critical role in the country's economy. To support the transition to a circular economy, there is a need for skills in **sustainable agricultural practices and resource-efficient farming methods.** This includes the development of expertise in precision agriculture, water management, and soil health, which are crucial for reducing waste and improving the sustainability of agricultural operations. Professionals with these skills will be essential for implementing technologies that enhance resource efficiency and environmental sustainability in Uzbekistan's agricultural sector.

Finally, as Uzbekistan continues to grow **its chemical and building materials industries**, there is an increasing requirement for skills in sustainable materials management and green chemistry. The focus on producing mineral fertilizers and building materials must be complemented by knowledge in reducing the environmental impact of these products and implementing recycling and waste management practices. Skills in developing and applying environmentally friendly materials and processes will be critical for aligning Uzbekistan's chemical and construction industries with circular economy goals.

The industry of **Tajikistan** consists of more than 90 industries and types of production. Tajikistan has sufficient reserves of raw materials for metallurgical, chemical, construction and other industries. The largest deposits of silver, gold, iron, lead, antimony, coal, table salt, precious stones and other minerals have been explored. In the structure of modern industry in Tajikistan, non-ferrous metallurgy plays a large role, which unites combined enterprises without a complete metallurgical cycle.

Manufacturing industry dominates in Tajikistan, accounting for more than 60% (see Figure 12).

Figure 12. Manufacturing industries in Tajikistan.



Source: Own elaboration

Tajikistan's diverse industrial landscape, comprising over 90 different sectors and a significant emphasis on non-ferrous metallurgy, demands a shift towards circular economy practices to enhance sustainability and resource efficiency. As the country capitalizes on its rich mineral deposits, including silver, gold, and coal, there is a growing need for specialized skills in sustainable mining and metallurgy. Future professionals will need expertise in developing and implementing circular economy strategies that minimize waste, improve recycling processes, and reduce environmental impact across the mining and metallurgical industries. Skills in **advanced materials science and sustainable extraction techniques** will be crucial for aligning Tajikistan's industrial practices with circular economy principles.

The agricultural sector in Tajikistan, which contributes significantly to the national economy, also requires a transition towards circular economy practices. To support sustainable agriculture, there is an increasing demand for skills in **resource-efficient farming, soil management, and innovative irrigation technologies.** Professionals with expertise in precision **agriculture and sustainable land management** will be essential for improving the efficiency of agricultural operations and reducing environmental degradation. Skills in waste management and the recycling of agricultural by-products will further support the shift towards a circular economy, ensuring that agricultural practices contribute positively to environmental sustainability.

As Turkmenistan continues to advance its economic development, the integration of circular economy principles will become increasingly vital to ensure sustainable growth and resource efficiency. In Turkmenistan's energy sector, which is central to the country's economy, there is a growing need for skills related to renewable energy technologies and energy efficiency. As the country seeks to diversify its energy sources and reduce its reliance on fossil fuels, expertise in solar, wind, and other **renewable energy technologies** will be crucial. Skills in energy conservation, smart grid management, and sustainable energy practices will support the development of a more resilient and environmentally friendly energy infrastructure. Agriculture is another crucial sector in Turkmenistan's economy, and its alignment with circular economy principles will be important for long-term sustainability. The adoption of sustainable agricultural practices, such as precision farming and organic agriculture, will require new **skills in soil management, water conservation, and waste reduction.** Expertise in modern irrigation systems, crop rotation techniques, and sustainable land management will be necessary to enhance productivity while minimizing environmental impact.

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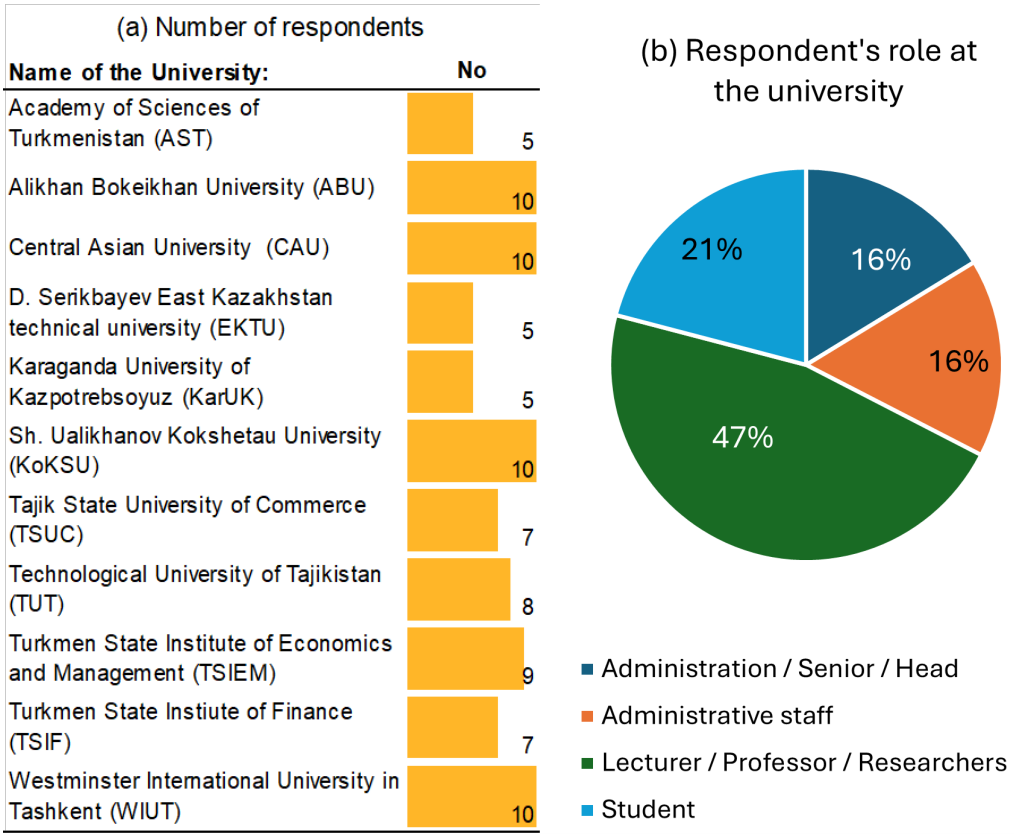
5. Analysis of Existing Curricula in Partner Universities:

Methodology

To conduct needs analysis, online questionnaires were distributed among students and staff of eleven universities. These universities include four institutions from Kazakhstan, three from Turkmenistan, two from Tajikistan and two from Uzbekistan. The data collection started in March of 2024 and was completed in April of the same year. There were as few as five and as many as ten respondents from each university (ref. Figure 13 (a)). Overall, 86 people participated in the questionnaires. Of them, 40 participants are lecturers or academic researchers, 18 are students, 14 are administrative staff, and the other 14 are staff in management positions. Although the data encompasses a small group, it provides valuable insight into the current programs of each university and the demand for courses on circular economy.

Figure 13. Number of respondents (a) from each university and their roles (b).



6.

Source: Own elaboration

The online questionnaire consisted of 6 sections, covering general information, educational programs, research activities, campus management, university partnership, and suggestions collected from each participant. The questionnaire consists mainly of multiple choice and yes/no questions, each followed by open questions to obtain clarifications and further details regarding the matter.

Results

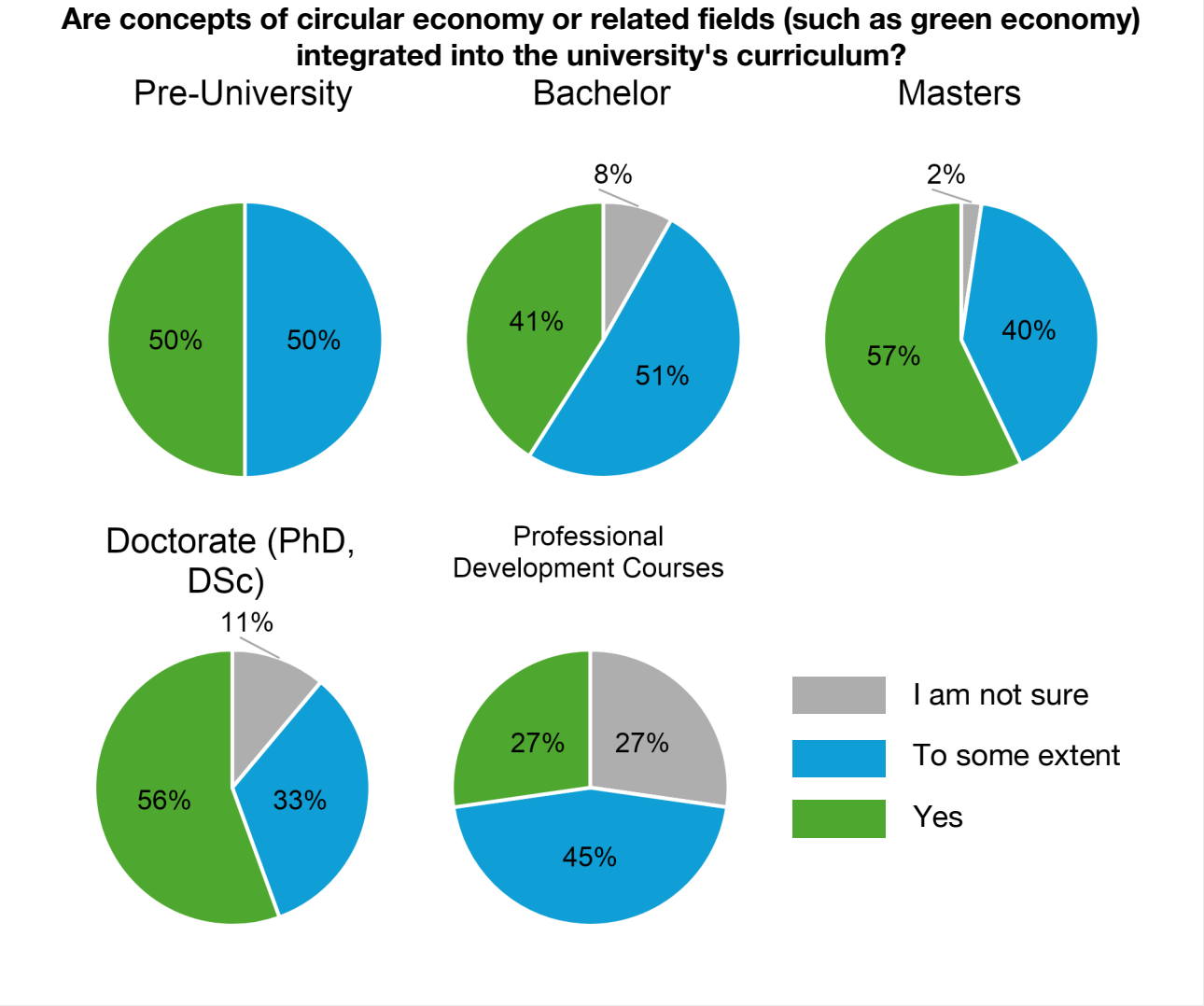
Table 20. Integration of the concept of Circular Economy to University degrees

	Pre-university		Bachelor		Masters		Doctorate (PhD, DSc)		Professional Development Courses	
No CE	15	*88%*	12	*16%*	30	*42%*	27	*75%*	29	*73%*
CE	2	*12%*	61	*84%*	42	*58%*	9	*25%*	11	*28%*
No Such Degree	69		13		14		50		46	

Source: Own elaboration

The survey shows that existing programs in pre-university courses, postgraduate degrees, and professional development courses only slightly cover the topics of circular economy (CE). The concept of circular economy is integrated in only 12% of pre-university courses, 25% of doctorate degrees and 28% of professional development courses (ref. Table 1). Although the situation seems to be better among bachelor's and master's degrees, with 84% of bachelor's and 58% of master's degrees in partnering universities providing knowledge on CE, there are still concerns regarding the depth of integration. Figure 14 shows that CE is integrated only to some extent in almost 50% of the cases.

Figure 14. The depth of integration.

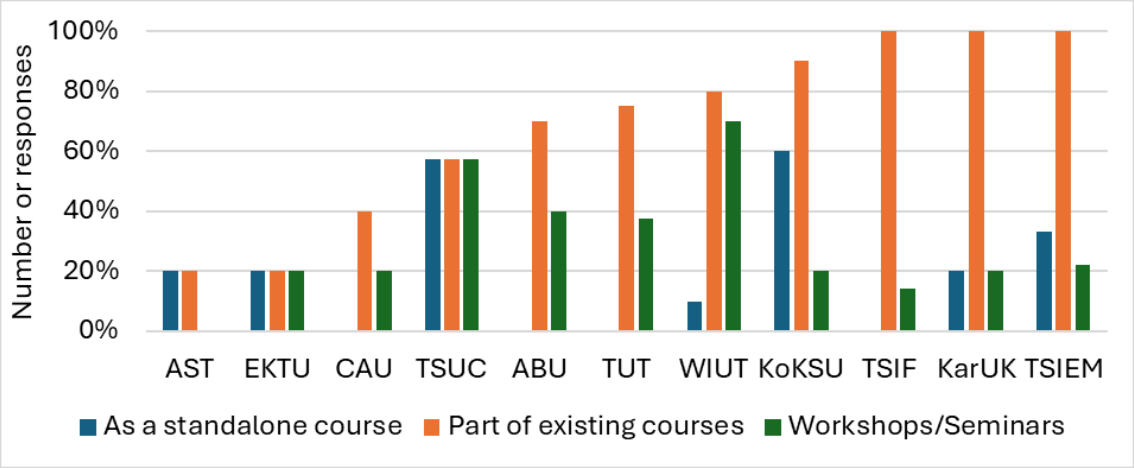


Source: Own elaboration

The reason to believe that CE is integrated into the curriculum only to some extent lies in the program's format. Most respondents agree that their university teaches concepts of circular economy as a part of the existing course (ref. Figure 2). In most cases, respondents clarified that it is one topic in a subject aimed to give a general idea about

the circular economy. This opinion was shared by respondents from the Tajik State University of Commerce (57%), Alikhan Bokeikhan University (70%), Technological University of Tajikistan (75%), Westminster International University in Tashkent (80%), Ualikhanov Kokshetau University (90%), Turkmen State Institute of Finance (100%), Karaganda University of Kazpotrebsoyuz (100%), and Turkmen State Institute of Economics and Management (100%). Another prominent format is separate workshops, seminars, or events organized in the university. However, very few survey participants are aware about these events; on average, 20% of respondents know that the university provides workshops on CE. Finally, only a few universities provide standalone courses on CE. Our analysis shows that Karaganda University of Kazpotrebsoyuz, Ualikhanov Kokshetau University, Tajik State University of Commerce, and East Kazakhstan Technical University provide standalone courses. However, only survey participants from the Tajik State University of Commerce (57%) and Ualikhanov Kokshetau University (60%) have mentioned about them.

Figure 15. Format



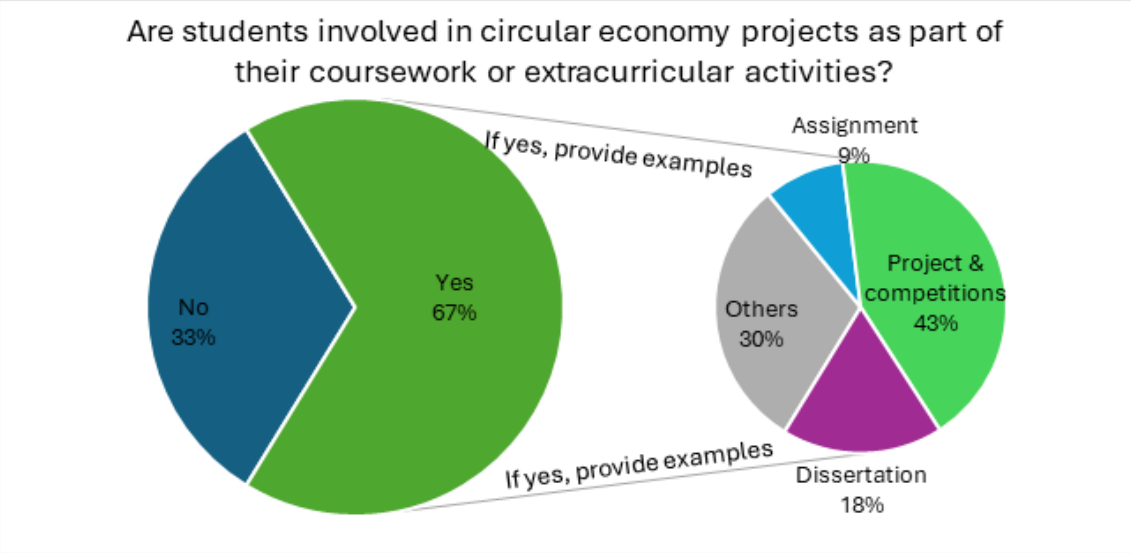
Source: Own elaboration

Challenges faced during the teaching process might be one of the reasons that keep universities from fully integrating CE into their curriculum (e.g. by providing standalone courses). Regarding the main obstacles in teaching CE, only 20 respondents believe that there are indeed obstacles in teaching, and **70% of them indicate that the lack of knowledge and study materials are the main obstacles.** According to the survey, the current strategies of selected universities to help teaching personnel overcome these problems include providing professional development workshops (40%) and granting access to specialized resources such as libraries on CE (17%). It is worth noting that 79% of those who believe the lack of knowledge and study materials is a problem have formal support for faculty organized by their university (providing workshops or resources).

However, despite the low awareness, lack of knowledge and absence of standalone courses provided by the selected universities, 67% of respondents admit that students are

involved in circular economy projects as part of extracurricular activities (see Figure 3). It mainly includes writing dissertations (18%) and assignments (9%) and participating in projects and competitions to brainstorm ideas (43%). Furthermore, 46% of respondents report the presence of student-led initiatives on the campus. This demonstrates interest among students in the concept of circular economy. Similar interest is observed among academics, with 50% of survey participants indicating that their university is involved in research related to the CE. Topics range from green economy and implementation of renewable energy to sustainable resource usage, recycling, and waste management.

Figure 16. Student's interest in CE



Source: Own elaboration

The survey also incorporated opinion-based responses. It included questions such as "In your opinion, what can be done to effectively integrate circular economy concepts into the university's framework?" and "Please share your vision of integrating circular economy in your university". Figure presents the word cloud on the most common words used to answer these questions. Most repeated words are "*develop/development*" of "*program*", "*courses*", "*students projects*" and "*seminars*" (except for the word "circular economy"). By categorizing responses, one can say that 29% of participants believe that CE can be integrated by introducing the new standalone courses, 19% by implementing CE-related projects, 17% via awareness raising and providing short courses, and 10% through an increasing partnership between universities and businesses. One respondent highlighted the importance of introducing the CE by saying, "*The introduction of a circular economy at a university has an essential role since the principle of sustainable development is one of the most pressing issues of our time*". Others highlighted that engaging everyone and not just a self-selected group of enthusiasts is important to ensure success. They argue that the more people are aware of the impact of CE on their lives,

the more they will be willing to make a difference. This can be achieved by educating students on CE.

Thus, the largest group believe that implementing new courses in the curriculum will increase awareness and participation. However, the nature of implementation should not be forced upon students. On this topic, one participant said: "*We must create such a concept so that students do not do this because they have to, but on the contrary, they should be happy about their concern for the environment*". To increase interest in the course, participants shared their thoughts on the context of the new program, highlighting the importance of "*developing courses and training programs on the concept of circular economy. This may include courses on sustainable development, environmental economics, waste management, etc. It should be complemented by increased support for research and projects aimed at exploring and applying circular economy principles in real life. This may include the development of new technologies and methods in the areas of waste management, energy efficiency, etc.*" They also highlight the importance of practical studies by saying that it is important to "*more actively introduce specialized courses into the training program, including applied ones*" and that "*creation of special courses or modules should combine the theory and practice of the circular economy. These courses may include learning about circular principles, modeling economic processes and analyzing their impact on various sectors*".

Although only 10% of survey respondents recommended increasing partnerships between universities and businesses, those who supported the idea of creating new courses also highlighted the importance of partnerships to provide practical knowledge for students. "*To further integrate the circular economy into the educational process of our university, it is necessary to establish closer cooperation with public organizations, businesses that implement green technologies and innovations in their production process"*, said one participant. Similarly, one stated, "*universities should collaborate with businesses and organizations implementing circular economy practices to create opportunities for students in real-life learning environments. It may include internships, capstone projects or research*".

Overall, survey participants support the idea of implementing a new course and believe that it should be complemented by practical learning and internship in partnering organizations that implement the circular economy concept.

Figure 17: World Cloud

7. Stakeholders analysis

Introduction

Considering that businesses play a critical role in integrating circularity into the economic system and the prevailing business model focuses on profit maximization, the case for a circular economy is increasingly being built on its potential for enhancing competitiveness and achieving high profitability.

The demand for resources is escalating, and we will be unable to meet this demand without adopting circular economy principles. This is not merely a matter of social and environmental responsibility but a question of survival. Incremental adjustments to

conventional business practices are insufficient; a radical paradigm shift is necessary. In this context, the circular jueconomy emerges as a transformative force, enabling the decoupling of overall growth from the consumption of scarce resources. By adopting circular economy principles, companies can increase production and consumption while reducing negative environmental impacts, fostering innovation, and strengthening their competitive advantage. Ultimately, these principles can unlock value potential equivalent to $4.5 trillion by 2030.

Global demand for food is projected to increase by 35%, water by 40%, and energy by 50% by 2030. Although we use natural resources more efficiently than before, consumption growth still outpaces our ability to replenish these resources. Every year, we consume 75% more natural resources than are replenished within the same period. The demand for non-renewable resources will continue to rise over the coming decades, with the extraction of metals projected to increase by nearly 250% by 2030. Based on the estimations, only 9% of extracted resources are returned to the production system as raw materials for new products after their initial use. According to data presented at the World Economic Forum, the global implementation of a circular economy by 2025 could reduce raw material costs by up to $1 trillion annually.

Transitioning from the linear "take-make-dispose" model to a circular economy requires significant systemic change and the active participation of diverse stakeholders. While the necessity of moving towards restorative and regenerative economic activities is widely recognized, the specifics of business models and implementation strategies remain unclear. The success of a circular economy hinges on the collaboration of stakeholders across all sectors and regions, as no single group can accomplish this transformation alone. Effective implementation demands that production methods and consumption patterns be fundamentally rethought, turning conventional practices on their head. Stakeholder engagement is critical, as each group has a role to play in influencing and facilitating circular economy outcomes.

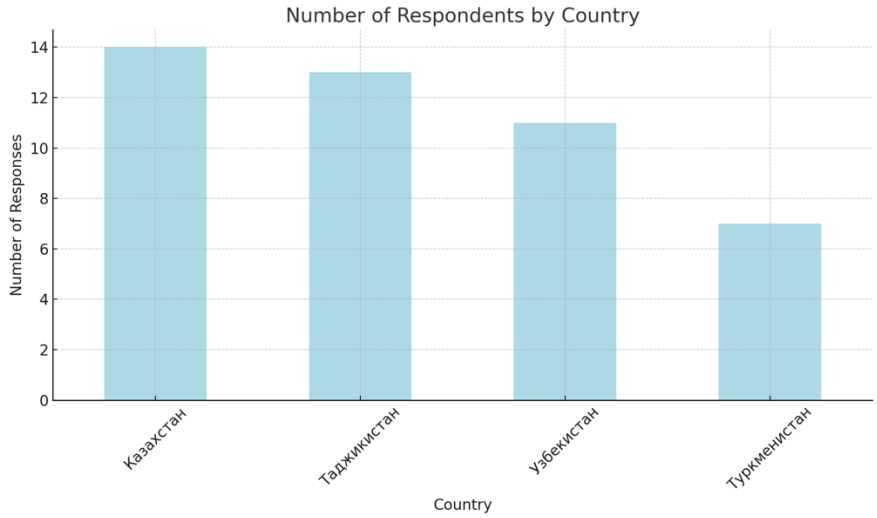
This study delves into stakeholder analysis within the context of a circular economy, examining how different stakeholders can impact and react to proposed initiatives. The use of stakeholder mapping tools, as recommended in strategic management literature, helps in understanding and managing these dynamics. Circular resources, or circular raw materials, are emerging as key business models for the short to medium term. Companies need to identify which materials can be replaced with circular alternatives, balancing operational and commercial considerations. In the long term, the aim is to achieve closed-loop production cycles to eliminate waste. This ambitious goal is unattainable without continuous cooperation among stakeholders from various sectors and industries, highlighting the indispensable nature of stakeholder engagement in fostering a successful circular economy transition.

Data and methodology

The survey was conducted August – September 2024 by the partners of the project. The methodology used in this survey aiming to ensure that participants from various sectors, roles, and regions are included to reflect the diversity of perspectives related to sustainability and the circular economy. The survey targets respondents from four Central Asian countries—Tajikistan, Turkmenistan, Kazakhstan, and Uzbekistan—ensuring regional diversity. Participants are categorized based on their sector (e.g., agribusiness, construction, mining) and roles (e.g., Manager, Technical Expert, Consultant). This stratification helps ensure that the responses reflect the views of different stakeholders, making the findings more generalizable across sectors and regions. However, with only **45 responses**, the sample size may limit the full representativeness across such a wide range of stakeholders.

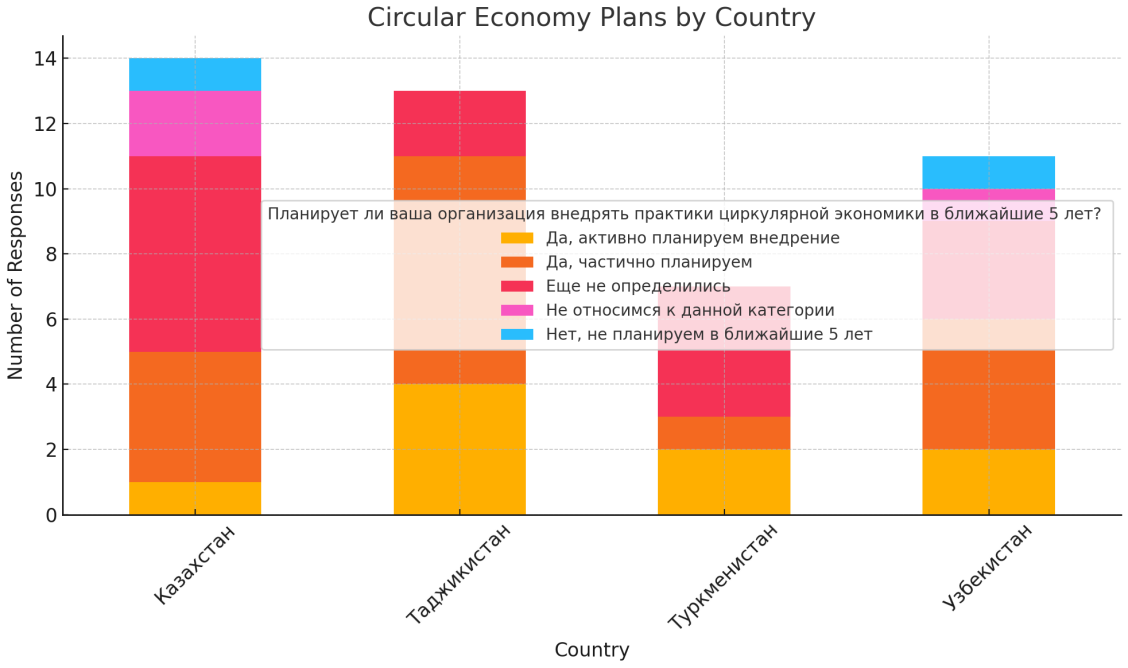
Survey Design methodology uses carefully worded questions that provide balanced response options. This structure avoids leading questions and allows respondents to express varying levels of agreement, knowledge, and involvement with circular economy practices, from "Very important" to "Unimportant," for example. The anonymity of the survey further minimizes bias, as participants are more likely to provide honest feedback when their identity is protected. Additionally, by including various stakeholders such as state authorities, market players, NGOs, and consumers, the survey accounts for multiple perspectives, preventing over-reliance on any single group's viewpoint.

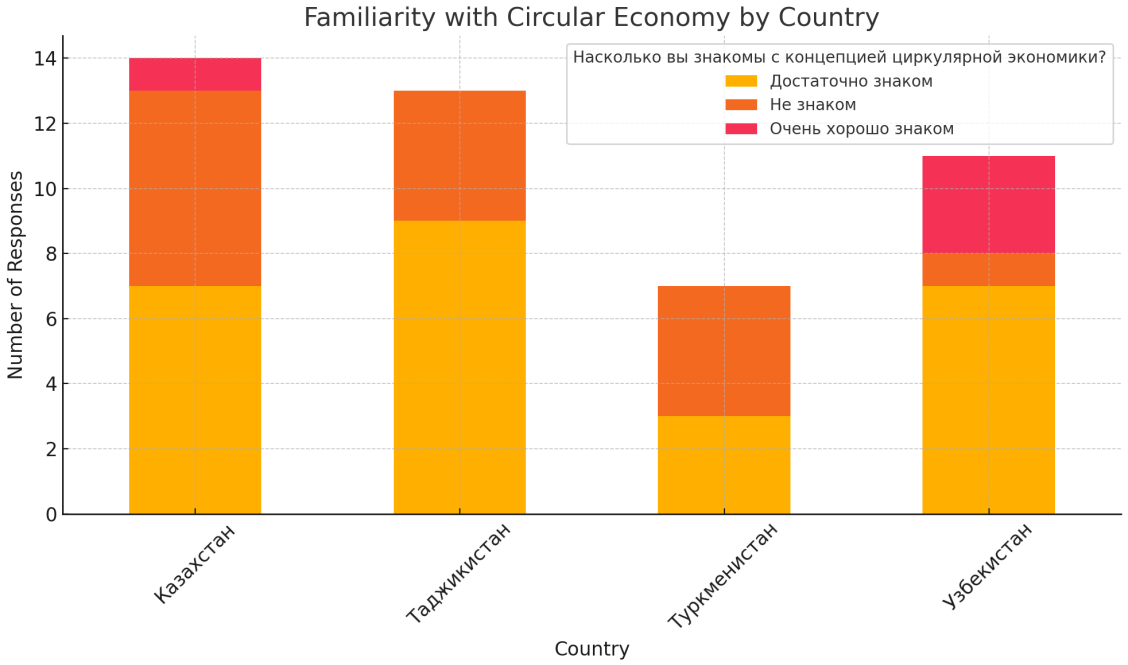
While the diversity of respondents is helpful, the relatively small number of participants may not fully capture the complexity of stakeholder views on circular economy practices.



Source: Own elaboration

The survey received responses from four countries: primarily from Kazakhstan, with other significant responses from Tajikistan, Uzbekistan, and Turkmenistan. Kazakhstan had the highest number of respondents.

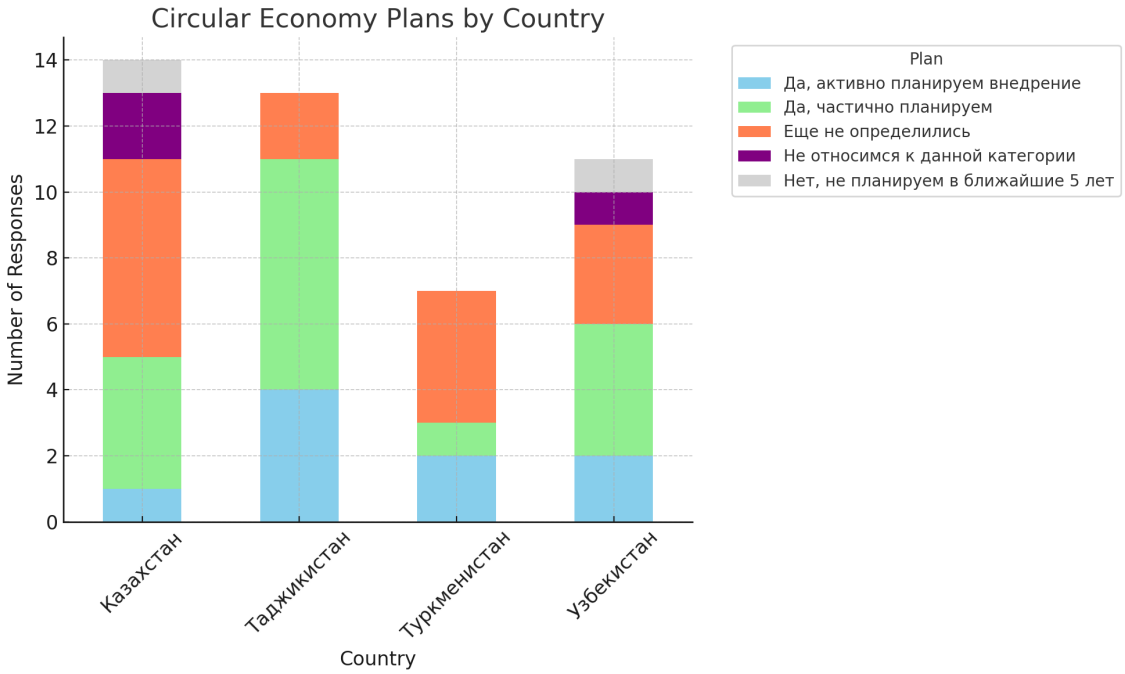


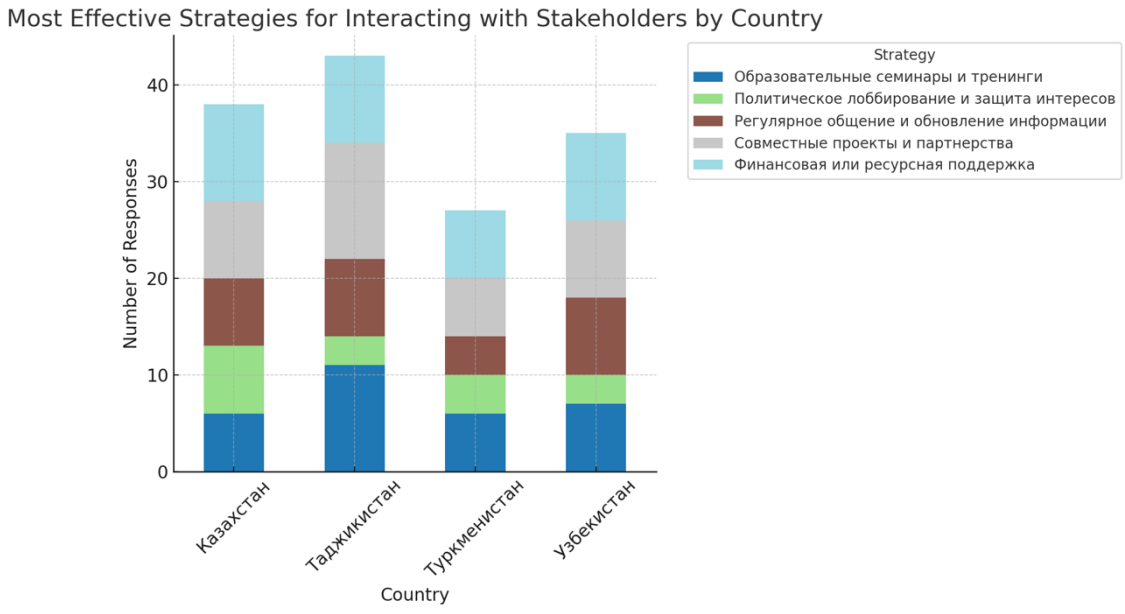


Source: Own elaboration

Respondents displayed different levels of familiarity with the concept of the circular economy (Figure). A significant portion reported being somewhat familiar with the idea, while a **smaller group indicated a high level of familiarity**, highlighting an opportunity to further increase education and awareness. Respondents from Kazakhstan and Uzbekistan demonstrated the highest familiarity with the concept. However,

paradoxically, these countries also had the largest number of respondents who believed that the circular economy is not applicable to their companies (Figure) and they don't have plans in future 5 years to implement it (Figure), suggesting potential misconceptions or gaps in understanding its relevance across various sectors.





Source: Own elaboration

The analysis of effective strategies for engaging stakeholders in circular economy practices reveals that across all countries, financial or resource support and educational seminars and trainings are seen as the most critical strategies. **Kazakhstan and**

Uzbekistan also emphasize the importance of joint projects and partnerships. **Tajikistan** prioritizes regular communication alongside **educational efforts**, and **Turkmenistan highlights financial support** as a key strategy. Overall, financial backing and capacity-building initiatives stand out as universally important across the regions.

Assessment of Stakeholders

We evaluated the stakeholders involved in circular economy initiatives by assessing them based on three key criteria: Influence, Interest, and Engagement. **Influence** was measured by their ability to shape or impact the outcomes of circular economy efforts, while **Interest** was gauged by how invested they are in these initiatives, based on the potential benefits or concerns they perceive. **Engagement** was assessed by their current level of participation and support for circular economy activities. We applied a scoring system to each criterion, allowing us to rank stakeholders accordingly. This approach helped us identify which groups hold the most influence and interest, as well as those that require further engagement to enhance their involvement in circular economy practices.

Stakeholder's Influence

The analysis of stakeholder influence on circular economy initiatives across countries shows that **government bodies consistently hold the highest influence**, particularly in Uzbekistan and Tajikistan, with scores above 4. **Large market players have significant influence in Kazakhstan** but much lower influence in Turkmenistan. Small businesses and cooperatives generally have lower influence, with Uzbekistan showing the highest score (3.27) and Turkmenistan the lowest (2.43). NGOs and academic institutions exhibit moderate influence across all countries, with scores between 3.15 and 3.29. This highlights **the dominant role of government** and the varying influence of market players and small businesses across regions.

In Kazakhstan, large market players hold the most significant influence, with a score reflecting their dominance in a more developed, resource-driven economy. This is consistent with Kazakhstan's economic model, where big companies, especially in the energy and mining sectors, play a critical role. In contrast, in Uzbekistan, small businesses and cooperatives hold more influence, with the highest score (3.27), highlighting the growing importance of small enterprises in a rapidly evolving economy. Meanwhile, in Turkmenistan, both large companies and small businesses exhibit lower influence, with small companies having the lowest score (2.43), likely due to the country's highly state-controlled economy. NGOs and academic institutions show moderate influence across all countries, with scores between 3.15 and 3.29, underscoring their supportive yet secondary role in driving circular economy initiatives compared to government and business stakeholders.

The interest of various stakeholders

The responses indicate how companies perceive the interest of various stakeholders in the circular economy. **NGOs, associations, and environmental groups are seen as having the highest interest (3.69/5),** likely because these organizations actively advocate for sustainability and influence circular economy policies. Academic and research institutions (3.57) are also viewed as highly interested, reflecting their role in developing innovative solutions and promoting awareness around circular practices. Government bodies (3.51) follow closely, as they are often responsible for regulations and policies that support the adoption of circular economy initiatives.

Large market players are perceived to have moderate interest (3.22), likely due to their balancing of circular economy goals with profitability and operational demands. Small businesses, consumers, suppliers, and logistics companies are viewed as having lower levels of interest, with scores around 2.7 to 2.8. This suggests that, according to the companies surveyed, these smaller stakeholders may be less focused on or aware of the benefits of the circular economy, possibly due to resource constraints or a lack of direct incentives. The overall perception highlights a gap in engagement, especially among smaller companies and supply chain actors, which may hinder the broader implementation of circular economy practices.

Breakdown by country demonstrated, the large market players in Kazakhstan perceived that have lower interest, with a score of 2.33. This could reflect different economic priorities, where larger companies in Kazakhstan, especially in sectors like oil, gas, and mining, may be less focused on circular economy initiatives and more driven by traditional business models centered around resource extraction.

Stakeholders engagement

The analysis reveals that **NGOs and environmental groups are seen as the most actively engaged stakeholders in circular economy development, particularly in Kazakhstan** and Tajikistan, with high engagement levels of 4.0 and 3.75, respectively. This suggests that these organizations play a leading role in promoting and implementing circular economy initiatives in these countries, likely due to their strong focus on sustainability advocacy and policy influence.

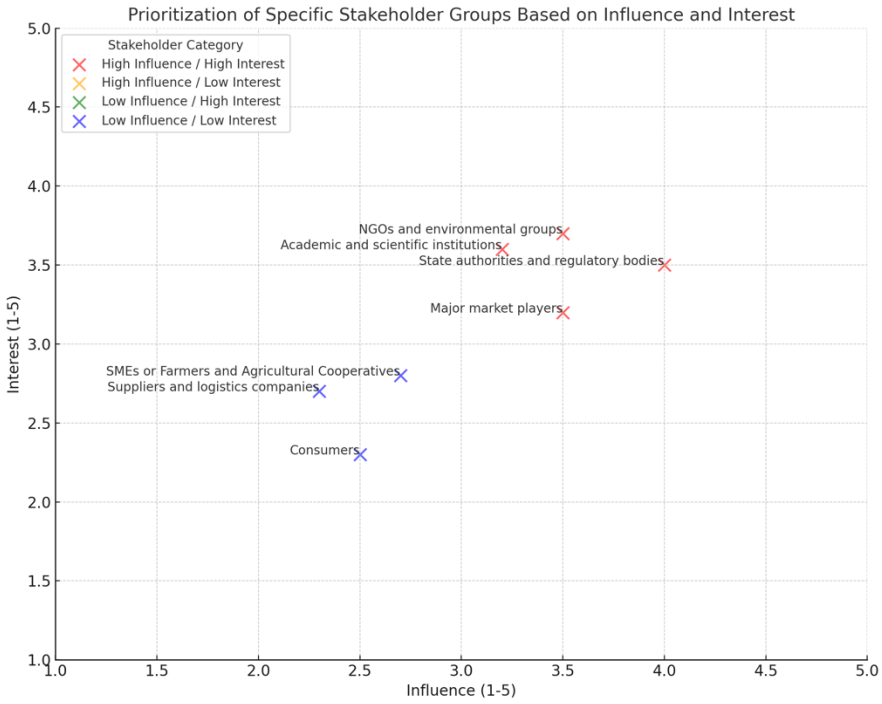
Interestingly, **media engagement is notably higher in Tajikistan (3.33) compared to other countries,** indicating that media in Tajikistan may be playing a more active role in raising awareness and promoting circular economy initiatives. Overall, the data shows that NGOs and academic institutions are at the forefront of driving circular economy efforts, while other stakeholder groups, such as consumers, suppliers, and the media in most countries, remain less involved, indicating potential areas for increased outreach and engagement.

Prioritization of Stakeholders

The matrix visualizes the prioritization of specific stakeholder groups based on their influence and interest in circular economy initiatives:

The matrix categorizes stakeholders based on their influence and interest in circular economy initiatives, offering a clear guide for engagement. High Influence / High Interest stakeholders, such as state authorities and NGOs, are critical to the success of these initiatives and must be actively engaged. Their role in shaping policy and advocacy makes them essential partners. On the other hand, **High Influence / Low Interest stakeholders, like major market players,** while powerful, may not be as committed. These groups require strategic communication to keep them informed and satisfied, ensuring their continued support even if their interest remains limited.

Low Influence / High Interest stakeholders, including academic institutions and SMEs, are eager to engage and contribute but lack the power to drive significant change on their own. Keeping them informed and involved is essential for innovation and knowledge-sharing. Low Influence / Low Interest stakeholders, **such as consumers and suppliers, currently play a passive role in circular economy initiatives.** Consumer behavior is critical in driving demand for sustainable products, and suppliers play a key role in implementing circular practices throughout the supply chain. If their interest or influence were to increase due to regulatory changes or market trends, their engagement would become more critical.



Source: Own elaboration

Conclusion

The survey conducted across four Central Asian countries—Kazakhstan, Uzbekistan, Tajikistan, and Turkmenistan—offers valuable insights into stakeholder perceptions of circular economy initiatives. The findings highlight key dynamics of influence, interest, and engagement among various stakeholder groups.

Government bodies, particularly in Uzbekistan and Tajikistan, emerge as the most influential, while large market players in Kazakhstan hold substantial power in shaping circular economy efforts. However, smaller businesses and cooperatives, especially in Uzbekistan, are also gaining influence, reflecting the evolving economic landscape. NGOs and academic institutions demonstrate moderate influence but maintain high interest and engagement across the region, indicating their crucial role in promoting sustainability.

The survey reveals that financial support and educational initiatives are viewed as the most effective strategies for advancing circular economy practices. Kazakhstan and Uzbekistan also emphasize the importance of partnerships and joint projects, while Tajikistan prioritizes communication efforts, and Turkmenistan focuses on financial backing.

Despite these insights, the survey underscores challenges in awareness and engagement, particularly among large market players in Kazakhstan, who show relatively low interest, and among smaller companies and supply chain actors, who may lack resources or incentives to fully engage in circular economy initiatives. Additionally, the limited sample size (45 responses) constrains the generalizability of the findings across such diverse sectors and regions.

In conclusion, while progress is evident, further efforts are needed to address gaps in understanding, particularly among key market players and smaller stakeholders. Financial support, capacity-building, and stronger partnerships will be critical to ensuring broader adoption and engagement in circular economy practices across Central Asia.