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GRINS FOUNDATION

DELIVERABLE 5.4.1: REGIONAL INDICATORS OF RISKS AND OPPORTUNITIES OF STRUCTURAL CHANGE TOWARDS CIRCULAR INNOVATIONS

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Executive summary

Measuring risks and opportunities of structural change towards circular innovations by means of regional indicators is very challenging in the Italian context due to the lack of data at disaggregate level. In this document, we first introduce the definition of Circular Economy (CE) adopted by European Institutions and then provide a list of potential indicators for monitoring the regional CE transition. The lack of data for monitoring the CE transition in Member States was recently pointed out by the European Court of Auditors (2023). This document moves exactly with the aim to indicate a way to fill this gap. To look at the relationship between regional specialization and circular economy transition, we need to isolate indicators from supply side (industries). To exhaustively address the issue of this deliverable, we need moreover to collect novel evidence from a micro-economic perspective. To this end, we propose a potential survey at firm-level on the CE transition that can allow us to produce detailed evidence at regional and industrial level.

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1. Measuring Circular Economy (CE) Transition

1.1 Introduction

The term "circular economy" has been used in various ways recently, with 221 different definitions, according to Kirchherr et al. (2023). In this work, we will be relying on the definition provided by Kirchherr et al. (2017) as it is the most widely accepted definition as of now: "*A circular economy describes an economic system that is based on business models which replace the 'end-of-life' concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes, thus operating at the micro level (products, companies, consumers), meso level (eco-industrial parks) and macro level (city, region, nation and beyond), with the aim to accomplish sustainable development, which implies creating environmental quality, economic prosperity and social equity, to the benefit of current and future generations*" (p. 224-225).

Among the various definitions, McCarthy et al. (2018) and OECD (2020) highlight the goals of the circular economy. The first emphasizes that the circular economy should reduce the extraction of virgin natural resources, moderate exposure to supply risks, reduce environmental pressures, and create new economic opportunities by using resources more efficiently, such as closing, extending, and narrowing material loops. The second points out that the goals of the circular economy should be to maximize the economy's materials and products value, minimize material consumption, and prevent waste, with a special focus on the reduction of hazardous components. In fact, the circular economy plays a vital role in attaining the United Nations Sustainable Development Goals and the Paris Climate Change Agreement. Specifically, the circular economy is a crucial aspect in achieving the following SDGs: Affordable and Clean Energy (7), Economic Growth (8), Sustainable Cities and Communities (11), Responsible Consumption and Production (12), Climate Change (13), Life below Water (14), and Life on Land (15).

Although the concept of circular economy has been gaining attention from scholars and institutions in recent years, there is a dearth of clear information regarding regional indicators of CE in the available literature. At the international level, the OECD has a dedicated section for "cities and regions" that provides crucial indicators. It is important to have regional indicators to measure the extent of this transition, as cities and regions are the key players in most policy areas that underlie the implementation of the circular economy (OECD, 2020). As discussed in C40 (2011), cities and regions can implement land use planning and policies, facilitate redevelopment and regeneration, support farmers' markets and urban food production, and create climate adaptation plans.

It's not enough to just examine structural changes to comprehend the transition towards a circular economy. A more comprehensive impact analysis is crucial. In 2015, the European Circular Economy Action Plan was adopted for the first time to simulate the shift of European countries towards a circular economy. The details of its program, recently updated in 2019, will be elaborated further. Despite efforts to promote the circular economy through the EU's 2015 Circular Economy Action Plan, the European Court of Auditors is concerned about the lack of comprehensive data. In a recent report, the Court highlighted the challenge of assessing Member States' progress due to insufficient information. The absence of clear and up-to-date data makes it difficult to evaluate the effectiveness of circular policies and verify goal achievement. A more comprehensive impact analysis is crucial to address these issues and ensure the success of the Circular Economy Action Plan.

The transition to a circular economy (CE) is critically interrelated with the concept of resilience, and firms must develop adequate adaptive and transformative capacities (Kennedy and Linnenluecke, 2022). In this context, the role of institutions is important to promote technological development and innovation, but also to mitigate the risks associated with the transition that inevitably will see some regions and some sectors more negatively affected than others (Henrysson and Nuur, 2021).

The transition to a CE comes with several opportunities and challenges. Major opportunities are represented by new job opportunities that will be generated; the reduction of costs through sustainable supply chains and end-of-life management; substantial net material savings; and less production complexity (MacArthur, 2013; Kumar et al, 2019). In this context, it is crucial to understand sector-specific opportunities to speed up the transition to a CE and see how these opportunities can be translated into concrete support for the transformation. For example, the valorisation of waste as a raw material resource, in sectors like mining, can represent one of the key strategies to face shortages in the supply of metals, which will be increasingly necessary for the green transition (Kinnunen and Kaksonen, 2019).

On the contrary, major barriers to implementation of CE are related to the quality issues, certification and price of recycled and second raw materials; supply chain complexities; coordination problems between companies; design, production and disassembly of products; high start-up/investment costs; and lack of technical expertise (Scarpellini et al, 2019; Camilleri, 2020; Jaeger and Upadhyay, 2020; Marino and Pariso, 2021). In addition, sectors that are more deeply involved in the transition also – as textile – face sector-specific barriers, for example in terms of poor consumer demand and awareness and lack of disposal and collection practices (Koszewska, 2018).

In EU, the presence of a "two-speed" Europe is currently seeing the Western countries leading the transition (Germany, Belgium, Spain, France, Italy, the Netherlands) and Central and Eastern countries lagging behind (Mazur-Wierzbicka, 2021). While the transition to CE will involve all types of companies, it is certainly true that SMEs will be those in need of greater financial and technical support. Currently, SMEs in EU are facing a heterogeneous transition across countries and sectors, with some successful best practices that however cannot be transferred to other sectors, together with the necessity to develop a better legal framework and ambitious government actions, specifically in terms of policies (Marino and Pariso, 2021).

1.2 Institutional approaches at international level

1.2.1 SDGs CE Indicators

The United Nations Development Programme (UNDP) created 17 Sustainable Development Goals in 2016. These goals include responsible production, consumption, climate action, and resource utilisation. The circular economy is crucial in achieving several SDGs, with SDG 12: Responsible Consumption and Production being significant. This goal promotes sustainable consumption and production patterns to support current and future livelihoods. Our current methods of production and consumption are unsustainable and cannot support the current population growth rate. The environmental breakdown is a significant risk facing the earth, as highlighted by Laybourn-Langton et al. (2019), and is directly linked to our consumption and production practices.

In Table 1.1, we can find a detailed summary of the SDG 12 targets and indicators. As we can see, the table includes indicators related to the widely used recycling and reusing rates and targets focused on developing tools and practices that increase general awareness about risks and needs.

Table 1.1 SDG 12 Indicators

Targets	Indicators

Target 12.1: Implement the 10-Year Framework of Programmes on Sustainable Consumption and Production Patterns, all countries taking action, with developed countries taking the lead, taking into account the development and capabilities of developing countries	**Indicator 12.1.1:** Number of countries developing, adopting or implementing policy instruments aimed at supporting the shift to sustainable consumption and production
Target 12.2: By 2030, achieve the sustainable management and efficient use of natural resources	**Indicator 12.2.1:** Material footprint, material footprint per capita, and material footprint per GDP
	Indicator 12.2.2: Domestic material consumption, domestic material consumption per capita, and domestic material consumption per GDP
Target 12.3: By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses	**Indicator 12.3.1:** (a) Food loss index and (b) food waste index
Target 12.4: By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment	**Indicator 12.4.1:** Number of parties to international multilateral environmental agreements on hazardous waste, and other chemicals that meet their commitments and obligations in transmitting information as required by each relevant agreement
	Indicator 12.4.2: (a) Hazardous waste generated per capita; and (b) proportion of hazardous waste treated, by type of treatment
Target 12.5: By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse	**Indicator 12.5.1:** National recycling rate, tons of material recycled
Target 12.6: Encourage companies, especially large and transnational companies, to adopt sustainable practices	**Indicator 12.6.1:** Number of companies publishing sustainability reports

and to integrate sustainability information into their reporting cycle	
Target 12.7: Promote public procurement practices that are sustainable, in accordance with national policies and priorities	**Indicator 12.7.1:** Number of countries implementing sustainable public procurement policies and action plans
Target 12.8: By 2030, ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature	**Indicator 12.8.1:** Extent to which (i) global citizenship education and (ii) education for sustainable development are mainstreamed in (a) national education policies; (b) curricula; (c) teacher education; and (d) student assessment
Target 12.a: Support developing countries to strengthen their scientific and technological capacity to move towards more sustainable patterns of consumption and production	**Indicator 12.a.1:** Installed renewable energy-generating capacity in developing countries (in watts per capita)
Target 12.b: Develop and implement tools to monitor sustainable development impacts for sustainable tourism that creates jobs and promotes local culture and products	**Indicator 12.b.1:** Implementation of standard accounting tools to monitor the economic and environmental aspects of tourism sustainability
Target 12.c: Rationalize inefficient fossil-fuel subsidies that encourage wasteful consumption by removing market distortions, in accordance with national circumstances, including by restructuring taxation and phasing out those harmful subsidies, where they exist, to reflect their environmental impacts, taking fully into account the specific needs and conditions of developing countries and minimizing the possible adverse impacts on their development in a manner that protects the poor and the affected communities	**Indicator 12.c.1:** Amount of fossil-fuel subsidies (production and consumption) per unit of GDP

Source: www.unstats.un.org

1.2.2 The European CE Action Plan

The first European Circular Economy Action Plan was adopted in December 2015 and was aimed at stimulating the transition of European countries towards a circular economy. The plan, made of 54 actions,[1] proposed measure regarding the entire product life cycle – "*closing the loop*"[2] from production and consumption, to waste management and secondary raw materials. Five priority areas were identified in the plan, including *i)* plastics; *ii)* food waste; *iii)* critical raw materials; *iv)* construction and demolition; *v)* biomass and bio-based products.

In January 2018, a monitoring framework was adopted "*to strengthen and assess the progress towards circular economy, while minimising the administrative burden*".[3] The plan was fully completed in 2019 and the new Circular Economy Action Plan was adopted in March 2020, as the main component of the European Green Deal in December 2019. The plan, in line with the EU's 2050 climate neutrality target, promotes legislative and non-legislative measures with 35 actions,[4] about the design of products, promotion of circular economy processes and sustainable consumption and waste prevention.

Different from the first plan targeting priority areas, the new plan targets specific resource-intensive industrial sectors that have a high potential for circularity. The sectors targeted include *i)* electronics and ICT; *ii)* batteries and vehicles; *iii)* packaging; *iv)* plastics; *v)* textiles; *vi)* construction and buildings; *vii)* food, water and nutrients.

For **electronics and ICT,** a Circular Electronics Initiative will be presented by the Commission to promote energy efficiency and durability, reparability, upgradability, maintenance, reuse and recycling of the devices. Other measures will be aimed to promote the implementation of the right-to-repair, introduction of standard chargers, improving the collection and treatment of waste and reducing the hazardous components of devices.

[1] https://eur-lex.europa.eu/resource.html?uri=cellar:8a8ef5e8-99a0-11e5-b3b7-01aa75ed71a1.0012.02/DOC_2&format=PDF
[2] COM(2015) 614 final "Closing the loop - An EU action plan for the Circular Economy", Brussels, 2.12.2015
[3] COM(2018) 29 final "Communication from the commission to the European parliament, the council, the European economic and social committee and the committee of the regions on a monitoring framework for the circular economy", Strasbourg, 16.1.2018
[4] https://eur-lex.europa.eu/resource.html?uri=cellar:9903b325-6388-11ea-b735-01aa75ed71a1.0017.02/DOC_2&format=PDF

For **batteries and vehicles,** measures are aimed at improving the collection and recycling of batteries, ensuring the recovery of the valuable materials. Other measures are directed towards phasing out the use of non-rechargeable batteries and promoting greater transparency for battery manufacturing, about environmental, and ethical aspects and terms of security of supply.

Measures towards **packaging** are directed towards the reduction, re-design and re-use, to ensure that all packaging on the EU market is reusable or recyclable by 2030. Mandatory requirements for recycled content and waste reduction measures for essential products will instead be the first strategy with regard to **plastics**. Other measures are aimed at reducing the amount of added microplastics, creating standards, and more excellent monitoring and promotion of bio-degradable plastic.

For **textiles**, adopting a new comprehensive strategy and a sustainable product framework will promote the adoption of sustainable textiles and promote activities aimed at sorting, re-using and recycling of textiles.

A comprehensive Strategy for a Sustainable Built Environment will instead promote greater sustainability for the **construction and building** sectors. Measures will be aimed at improving durability and adaptability, promoting initiatives to reduce soil sealing and promote energy efficiency.

For **food, water, and nutrients,** together with the definition of a new target for food waste reduction, the Commission will propose measures that will facilitate water reuse and efficiency, as well as industrial processes and an Integrated Nutrient Management Plan, to promote a more sustainable application of nutrients. In addition, measures towards wastewater treatment and sewage sludge will be considered by the Commission.

A new monitoring framework was adopted in May 2023. The framework consists of five thematic sections with eleven statistical indicators. These indicators measure the material and consumption footprint as well as resource productivity. Eurostat is responsible for producing most indicators and making them easily accessible to citizens and policymakers. Please refer to the table below for a complete list of these indicators.

Table 1.2 Eurostat CE Indicators

Sector	Indicator name
Production and consumption	Material footprint
	Resource productivity
	Waste generation per capita
	Generation of waste excluding major mineral wastes per GDP unit
	Generation of municipal waste per capita
	Food waste

	Generation of packaging waste per capita
	Generation of plastic packaging waste per capita
Waste management	Recycling rate of municipal waste
	Recycling rate of all waste excluding major mineral waste
	Recycling rate of packaging waste by type of packaging
	Recycling rate of waste of electrical and electronic equipment (WEEE) separately collected
Secondary raw materials	Circular material use rate
	Contribution of recycled materials to raw materials demand - end-of-life recycling input rates (EOL-RIR) - by raw materials
	Trade in recyclable raw materials - by raw materials, by stock or flow
Competitiveness and innovation	Private investment and gross added value related to circular economy sectors - by environment indicator
	Persons employed in circular economy sectors
	Patents related to recycling and secondary raw materials
Global sustainability and resilience	Consumption footprint - by type
	Greenhouse gases emissions from production activities
	Material import dependency
	EU self-sufficiency for raw materials - by raw material - by extraction or processing

Source: Eurostat

1.2.3 OECD Circular Economy Indicators

The OECD has compiled a list of over 400 circular economy indicators from 2018 to 2020. These indicators fall under five main categories: Environment, Governance, Economic and Business, Technology, and Jobs. Environment constitutes 39% of the indicators, Governance 34%, Economic and Business 14%, Technology 8%, and Jobs 5%. Table 1.3 provides a detailed classification of indicators, including 33 subcategories and 11 sectors. OECD has classified inventory into 11 sectors. According to OECD (2020), the largest sector (31%) does not refer to any specific area, while 20% is dedicated to waste, 10% to resources and materials, 8% to reuse, repair, and sharing, 7% to the built environment, 7% to energy, 3% to food, 3% to water, 3% to public administration, 2% to air, and 6% to other sectors. This classification helps to organise and analyse inventory data more effectively.

Table 1.3 OECD Categories and sub-categories of CE indicators	
	- Added value - Business - Economic efficiency - Economic structure

Economic and Business	- Gains and revenues - Investments - Productivity - Savings
Environment	- Efficiency - Emissions - Output material process - Production and consumption - Savings - Use - Other
Governance	- Awareness-raising - Capacity building - Collaboration - Education - Financing - Innovation, pilots and experiments - Monitoring and evaluation - Public procurement - Regulation - Stakeholder engagement - Strategy and initiatives - Other
Infrastructure and technology	- Area - Equipment - Facilities - Products and services - Other
Jobs	Jobs and human resources

We can summarize the relevant information of each point as follows. The transition towards a circular economy requires monitoring of all relevant public and private initiatives across the economy (1). A robust monitoring system is essential, which should include indicators such as material and waste flow, environmental footprint, economic and social impact, policy, process, and behaviour (2). The RACER criteria (Relevant, Accepted, Credible, Easy to monitor, and Robust) should be followed (3). The data underpinning the monitoring framework should be exploited and integrated from national, European, and international sources, policy information and new data sources (4). Changes should be captured at all scales, from global to local (5). The monitoring implementation should define relevant policy targets and objectives (6). Finally, the

visibility and clarity of the monitoring framework should be ensured through appropriate indicators, information, and possible data that are fully and freely available (7).

1.2.4 OECD Regional Indicators

The OECD (2020) offers a comprehensive range of indicators from both regional and local monitoring frameworks. As noted, there are some strategies at the regional level, including a set of performance indicators that align with the Circular Economy Monitoring Framework of the EC. The majority focus on measuring actions that should lead to a structural change in terms of circular economy. Other indicators include "the number of legislative and normative obstacles identified and addressed, the number of legislative and normative incentives created, the number of people and students trained in the circular economy field of activity, the number of seminars organised on the circular economy within the framework of the strategy, and the pilot cases implemented through calls for projects". Table 1.4 presents a selection of indicators from regional and local monitoring frameworks. The list of regional and local frameworks can be found in Annex 1.

Table 1.4. An OECD selection of indicators from local monitoring frameworks

Region/ City	Category				
	Economy and business	Environment	Governance	Infrastructure and technology	Jobs
Brussels-Capital Region	Economic operators supported in circular economies		Budget of pilot public contracts in a circular economy Students trained in the circular economy fields of activity	New districts incorporating the principles of the circular economy	Jobseekers who have been employed as a result of training on the circular economy
Catalonia (Spain)	Weight of the green economy in GDP	Environmental quality			Green employment rate

	Efficiency in resource productivity				
North Karellia (Finland)		Recycling rate of construction waste Separate collection rate of construction waste			
Scotland (UK)		Carbon impact of waste Total amount of waste produced by construction and demolition			
Amsterdam (Netherlands)	Net added value of the circular economy	CO2 emissions reduction Material savings			Net circular job growth
Greater Porto Area (Portugal)			Number of tender with circular criteria Level implementation of a training plan on the circular economy Level of implementation of the Environmental Action Plan		
Paris	Value creation of	CO2 avoided from the	Number of actors involved	Percentage of Paris'	Number of jobs created

	circular economy models Economic savings from recovery and reuse of materials	recovery and reuse of materials Energy consumption savings	in circular experimental projects Number of awareness-raising activities carried out for plastic use reduction Public procurement contracts with a circular economy dimension	territory covered by experimental areas for the recovery and reuse of building materials Number of collection points for reuse of materials	from reuse activities Number of jobs created by promoting circular consumption in the city
Toronto (Canada)	Cost savings	Waste reduction Raw materials avoided	Number of city contracts evaluated using circular economy principles		Number of green jobs created and secured
Turku (Finland)		Greenhouse gas emissions per capita Share of renewable energy in district heating			

Source: OECD (2020)

Useful information on circular economy is available under the sub-category "Environmental indicators in regions" in the OECD statistics databases' "Regions and Cities" category, as shown in Table 1.5. The majority of these indicators are contained in Environment and Transport sessions.

Table 1.5 CE Indicators in Regions and Cities	
Environment	Municipal Waste (in kilo-tonnes)
	Municipal Waste Rate (kilos per capita)
	Volume of recycled waste (Ktonnes)

	Share of municipal waste recycled
	Municipal waste used in controlled landfilling (Ktonnes)
	Share of municipal waste used in controlled landfilling
	Air Pollution in PM2.5 (average level in mg/m3 experienced by the population)
	Air Pollution in PM10 < 20 mg/m3 (number of inhabitants exposed to particles)
	Air Pollution in PM10 > 20 mg/m3 (number of inhabitants exposed to particles)
	CO2 Emissions (in kilo tonnes)
	CO2 Emissions Rate (in tonnes per capita)
	CO2 Emissions Share from the Energy Sector (in % of total emissions)
	CO2 Emissions Share from the Transport Sector (in % of total emissions)
	NO2 Emissions (in 10^n molecules/cm2)
	Net Ecosystem Productivity measured by CO2 Sequestration or Release (in g/m2)
Transport	Private vehicles fleet (number)
	Private vehicles rate (number of vehicles for 1000 population)
	Electric powered road motor vehicles fleet
	Electric powered road motor vehicles share (for 100 vehicles)
	Hybrid-powered road motor vehicles fleet
	Hybrid-powered road motor vehicles share (for 100 vehicles)
	New registered private vehicles (number)
	New registered private vehicles rate (number of vehicles for 1000 population)
	New registered electric-powered road motor vehicles
	New registered electric-powered road motor vehicles share (for 100 vehicles)
	New registered hybrid powered road motor vehicles
	New registered hybrid powered road motor vehicles share (for 100 vehicles)

Source: OECD.Stat

1.2.5 Bellagio Declaration

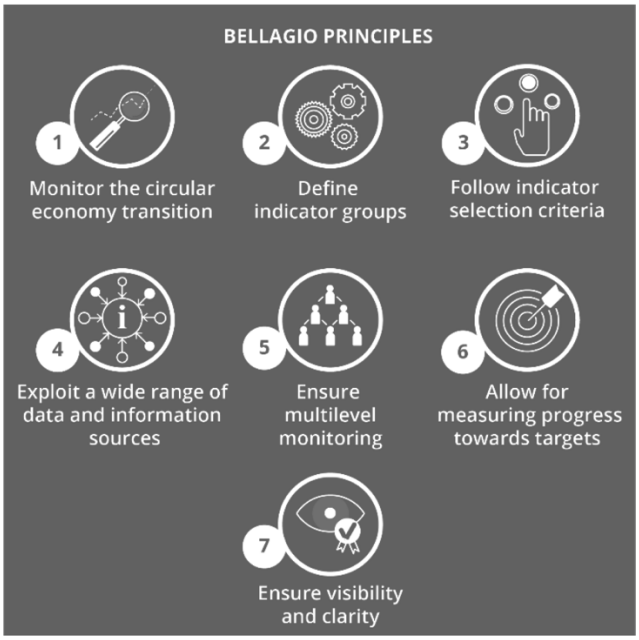
In 2020, the Bellagio Declaration was established by ISPRA[5] and EEA[6] to ensure that all relevant aspects are monitored and all parties involved in the transition to a circular economy are accounted for. The Declaration was endorsed by Germany, France, Slovakia, Switzerland, Netherlands, Austria and Italy. The Bellagio Declaration comprises

5 Istituto Superiore per la Protezione e la Ricerca Ambientale (ISPRA, www.isprambiente.gov.it)

6 European Environment Agency (EEA, www.eea.europa.eu)

a set of seven principles that capture the crucial elements of a monitoring framework for the circular economy transition. Figure 1.1 shows these principles.

Figure 1.1 Bellagio Principles



Source: Bellagio Declaration (2020)

2. Measuring Circular Economy Transition in Italy

2.1 Data at country, regional and micro level

2.1.1. Data at country and regional levels

We conducted desk research on Circular Economy reports published between 2018 and 2023. Our focus was on the indicators and measurements used in these reports. We identified the most commonly used Circular Economy indicators and created a database of them. We also explored institutional websites to gather more information.

We combined the data from both reports and institutional websites to create a draft database of which 257 indicators available at regional level, reported in Table 2.1. In

Our analysis revealed that while some information is only available at the national level, there are also indicators available at the regional level in Italy, particularly in the categories of Economy & Business, Governance, and Environment[7]. However, to access new regional indicators, it is necessary to communicate with statistics authorities and institutions.
Table 2.1 below contains the available regional indicators, we do not report the country level ones. It is useful to underline that, for the purposes of this work, indicators have been classified according their belonging to Family, Company and Public Administration categories. Here is an explanation of the criteria used for the categorization:

- **Household (H)**: Elements that seem to be related to families or citizens as individuals. For instance, issues related to water supplies reported by households, concerns about climate change and biodiversity loss.
- **Industry (I)**: Elements linked to industrial and commercial activities. For example, the production and consumption of electricity by businesses, greenhouse gas emissions by the energy sector and industrial activities.
-**Public Administration (PA)**: Elements associated with public services and public administration activities. For example, water resource management, municipal waste generation, greenhouse gas emissions from the public sector, air quality and environmental satisfaction.

Table 2.1: Data at regional level

SOURCE	TYPOLOGY	INFORMATION	Household, Industry and PA	AVAILABLE YEARS
ISTAT	Water Resources	Number of water bodies with groundwater in good quantitative quality state	PA	2016
ISTAT	Water Resources	Irregularities in water supply (Families reporting irregularities in water supply (thousands)	H	1995 - 2022 (missing 2004)
ISTAT	Water Resources	Water withdrawn (thousands of cubic meters)	PA	1999,2005, 2008, 2012
ISTAT	Water Resources	Potable water (thousands of cubic meters)	PA	1999,2005, 2008, 2012
ISTAT	Water Resources	Population of municipalities with sewage network service with complete treatment of conveyed effluents (number)	PA	1999,2005, 2008
ISTAT	Water Resources	Total Urban Equivalent Inhabitants (AETU) effectively served by secondary or tertiary type plants	PA	2005, 2008

[7] We refer to OECD EC categories.

ISTAT	Water Resources	Equivalent Inhabitants Served (AES) effectively by urban wastewater treatment plants in operation with secondary or tertiary treatment	PA	1999, 2005,2008, 2012,2015
ISTAT	Water Resources	Actual equivalent urban inhabitants served by treatment plants performing secondary and tertiary treatment	PA	2005, 2008,2012, 2015
ISTAT	Water Resources	Total Urban Equivalent Inhabitants (AETUs) actually served by secondary or tertiary plants	PA	2005, 2008,2012, 2015
ISTAT	Waste	Urban waste subject to separate collection (thousands of tons)	H	1996 - 2021
ISTAT	Waste	Total urban waste production (thousands of tons)	H	1996 - 2021
ISTAT	Waste	Urban waste (wet + green fraction) treated in composting plants (thousands of tons)	PA	2001 - 2021 (missing 2020)
ISTAT	Waste	Production of wet and green fraction (thousands of tons)	PA	2001 - 2021 (missing 2020)
ISTAT	Waste	Urban waste disposed of in landfills (thousands of tons)	PA	2002 - 2021
ISTAT	Energy	Total net electricity production	PA	1997 - 2020
ISTAT	Energy	Net electricity production through water plants	PA	2000 - 2012
ISTAT	Energy	Net electricity production through biomass	PA	2000 - 2012
ISTAT	Energy	Net electricity production through geothermal, wind, and photovoltaic plants	PA	2000 - 2012
ISTAT	Energy	Gross efficient power of renewable sources: HYDRO	PA	2000 - 2022
ISTAT	Energy	Gross efficient power of renewable sources: WIND	PA	2000 - 2022
ISTAT	Energy	Gross efficient power of renewable sources: PHOTOVOLTAIC	PA	2000 - 2022
ISTAT	Energy	Gross efficient power of renewable sources: GEOTHERMAL	PA	2000 - 2022
ISTAT	Energy	Gross efficient power of renewable sources: BIOMASS	PA	2000 - 2022
ISTAT	Energy	Total gross efficient power	PA	2000 - 2022
ISTAT	Energy	Population served by natural gas	PA	2002 - 2006

ISTAT	Energy	Gross production of renewable source plants	PA	2000 - 2021
ISTAT	Energy	Gross internal electricity consumption	PA	1997 - 2021
ISTAT	Energy	Produzione lorda degli impianti da fonti rinnovabili	PA	2000 - 2021
ISTAT	Energy	Gross electricity production through water plants	PA	2000 - 2021
ISTAT	Energy	Electricity consumption of the public administration	PA	2001 - 2021
ISTAT	Energy	ULA of the PA	PA	2001 - 2020
ISTAT	Competitiveness	Electricity consumption of agricultural enterprises	I	2001 - 2022
ISTAT	Competitiveness	Electricity consumption of industrial enterprises	I	2001 - 2022
ISTAT	Competitiveness	Electricity consumption of tertiary enterprises for saleable services	I	2001 - 2022
ISTAT	Competitiveness	Gross final energy consumption	PA	2012 - 2022
ISTAT	Competitiveness	Number of sites of organizations with ISO 14001 certification (as of 30-09 of the year)	I	1998 - 2020
ISTAT	Competitiveness	Total number of certified organization sites (as of 30-09 of the year)	I	1998 - 2020
ISTAT	Air quality	CO2 emissions from road transport	PA	2010,2015, 2017, 2019
ISTAT	Air quality	Greenhouse gas emissions in agriculture	PA	2010,2015, 2017, 2019
ISTAT	Air quality	Greenhouse gas emissions from the energy sector	PA	2010,2015, 2017, 2019
ISTAT	Air quality	Greenhouse gas emissions from road transport (CO2 Teq.)	PA	1996 - 2003; 2005, 2010,2015,2017 ,2019
ISTAT	Air Quality	Greenhouse gas emissions	PA	1995,2000,200 5,2015,2017,20 19
ISTAT	Air Quality	Total CO2 emissions	PA	1995,2000,200 5,2015,2017,20 19
ISTAT	Air Quality	Selected air quality monitoring stations (new series)	PA	2002 - 2012, missing 2004
ISTAT	BES	Bathing marine coasts	PA	2018 - 2023
ISTAT	BES	Historical green density	PA	2018 - 2023

ISTAT	BES	Dispersion from municipal water network	PA	2018 - 2023
ISTAT	BES	Availability of urban greenery	PA	2018 - 2023
ISTAT	BES	Electricity from renewable sources	PA	2018 - 2023
ISTAT	BES	Soil sealing from artificial coverage	PA	2018 - 2023
ISTAT	BES	Innovation of the production system	I	2018 - 2023
ISTAT	BES	Dissatisfaction with the landscape of the place of residence	H	2018 - 2023
ISTAT	BES	Research intensity	I	2018 - 2023
ISTAT	BES	Concern for climate change	H	2018 - 2023
ISTAT	BES	Concern for loss of biodiversity	H	2018 - 2023
ISTAT	BES	Propensity for patenting	I	2018 - 2023
ISTAT	BES	Air quality - PM2.5	PA	2018 - 2023
ISTAT	BES	Urban waste produced	H	2018 - 2023
ISTAT	BES	Selective collection service of urban waste	PA	2018 - 2023
ISTAT	BES	Contaminated sites	PA	2018 - 2023
ISTAT	BES	Satisfaction with the environmental situation	H	2018 - 2023
ISTAT	BES	Wastewater treatment	PA	2018 - 2023
OECD	Environmental indicators in regions	Municipal Waste	PA	2000 - 2020
OECD	Environmental indicators in regions	Volume of recycled waste	PA	2000 - 2020
OECD	Environmental indicators in regions	Municipal Waste used in controlled landfilling	PA	2002 - 2020
OECD	Environmental indicators in regions	Air pollution	PA	2000 - 2020
OECD	Environmental indicators in regions	CO2 Emissions	PA	2018
ISPRA	Certifications	No. of EU Ecolabel Licenses for Products	PA	2015
ISPRA	Municipal waste production	Urban Waste Production	PA	2007 - 2012
ISPRA	TREND AND SECTORAL DISAGGREGATION	Regional F-Gas Emissions	PA	1990 - 2010 (every five years)
ISPRA	TREND AND SECTORAL DISAGGREGATION	Regional Nitrous Oxide Emissions	PA	1990 - 2010 (every five years)

ISPRA	TREND AND SECTORAL DISAGGREGATION	Regional Carbon Dioxide Emissions	PA	1990 - 2010 (every five years)
ISPRA	TREND AND SECTORAL DISAGGREGATION	Regional Methane Emissions	PA	1990 - 2010 (every five years)
ISPRA	Environmental certification	Number of EMAS Registered Organizations/Companies per Region	I	2002 - 2022
ISPRA	Environmental certification	Evolution of the Number of UNI EN ISO 14001 Certifications	I	2004 - 2022
ISPRA	QUANTITY OF SPECIAL WASTE RECOVERED	Recovered Special Waste	PA	2018,2019,2020
ISPRA	QUANTITY OF SPECIAL WASTE RECOVERED	Recovered Hazardous Special Waste	PA	2018,2019,2020
ISPRA	,Undifferentiated collection (RI) per capita	Per Capita Unsorted Collection (RI)	PA	2022
ISPRA	Separate collection (RD) per capita	Per Capita Differentiated Collection (RD)	PA	2022
OPENCOESIONE	Environment Project	Restoration of urban forests, the settlement of hydrogeological disruptions, hydrogeological risk mitigation works, maintenance works on the water network, and projects for the enjoyment of natural areas. The interventions aim to improve land safety, water resource management, and environmental enhancement.	PA	2022
BANCA D'ITALIA	ERIT Tables	Advancement of the ERDF and ESF Community Programs 2014-2020	PA	2023
BANCA D'ITALIA	ERIT Tables	Financial allocations of the Operational Programs under the Partnership Agreement 2021-27	PA	2023
ISTAT	Material Flow	Direct material consumption (DMC= UMDEXT+IWORLD-OWORLD)	PA	2016 - 2020
	Material Flow	Used material domestic extraction (UMDEXT)	PA	2016 - 2020
	Material Flow	Used material domestic extraction - Biomass	PA	2016 - 2020

	Material Flow	Used material domestic extraction - Minerals	PA	2016 - 2020
	Material Flow	Used material domestic extraction - Fossil fuels	PA	2016 - 2020
	Material Flow	Physical trade balance (PTB=IWORLD-OWORLD)	PA	2016 - 2020
	Enterprises economic indicators	Local units	I	2020
	Enterprises economic indicators	Turnover	I	2020
	Enterprises economic indicators	Value added at factor cost	I	2020
	Enterprises economic indicators	Total purchases of goods and services	I	2020
	Enterprises economic indicators	Wages and salaries	I	2020
	Enterprises economic indicators	Persons employed	I	2020
	Enterprises economic indicators	Employees	I	2020
	Enterprises economic indicators	Employment in persons, by industry and by employment status	I	2019-2020-2021
ISPRA	EU Ecolabel	Number of Ecolabel products	PA	2004 - 2023
	EU Ecolabel	Number of Ecolabel licenses issued	PA	2004 - 2023
	EU Ecolabel	Number of Ecolabel licenses, by product group	PA	2004 - 2023
	EU Ecolabel	Number of Ecolabel licenses, products	PA	2004 - 2023
	EU Ecolabel	Number of Ecolabel licenses, services	PA	2004 - 2023
ISPRA - Catasto Rifiuti	Production and separate collection of municipal waste	DR per capita	I	2014 - 2021
ISPRA - Catasto Rifiuti	Production and separate collection of municipal waste	RU per capita	I	2014 - 2021
ISPRA - Catasto Rifiuti	Production of special waste	Production of special non-hazardous waste by economic activity	I	2014 - 2021
ISPRA - Catasto Rifiuti	Production of special waste	Production of special hazardous waste by economic activity	I	2014 - 2021

ISPRA - Catasto Rifiuti	Production of special waste	Production of special non-hazardous waste by Chapter of the European Waste List	I	2014 - 2021
ISPRA - Catasto Rifiuti	Production of special waste	Production of special hazardous waste by Chapter of the European Waste List	I	2014 - 2021
ISPRA - Catasto Rifiuti	Special waste management	Recovery operation of non-hazardous waste - R1: Principal use as a fuel or other means to generate energy	PA	2014 - 2021
ISPRA - Catasto Rifiuti	Special waste management	Non-hazardous waste recovery operation - R2: Solvent regeneration/recovery	PA	2014 - 2021
ISPRA - Catasto Rifiuti	Special waste management	Non-hazardous waste recovery operation - R3: Recycling/recovery of organic substances not used as solvents (including composting and other biological transformation operations)	PA	2014 - 2021
ISPRA - Catasto Rifiuti	Special waste management	Non-hazardous waste recovery operation - R4: Recycling/recovery of metals and metal compounds	PA	2014 - 2021
ISPRA - Catasto Rifiuti	Special waste management	Non-hazardous waste recovery operation - R5: Recycling/recovery of other inorganic substances	PA	2014 - 2021
ISPRA - Catasto Rifiuti	Special waste management	Non-hazardous waste recovery operation - Regeneration of acids or bases	PA	2014 - 2021
ISPRA - Catasto Rifiuti	Special waste management	Non-hazardous waste recovery operation - R7: Recovery of products used to capture pollutants	PA	2014 - 2021
ISPRA - Catasto Rifiuti	Special waste management	Non-hazardous waste recovery operation - R8: Recovery of products from catalysts	PA	2014 - 2021
ISPRA - Catasto Rifiuti	Special waste management	Non-hazardous waste recovery operation - R9: Regeneration or other reuse of oils	PA	2014 - 2021
ISPRA - Catasto Rifiuti	Special waste management	Non-hazardous waste recovery operation - R10: Land spreading for the benefit of agriculture or ecology	PA	2014 - 2021

ISPRA - Catasto Rifiuti	Special waste management	Non-hazardous waste recovery operation - R11: Use of waste obtained from one of the operations listed in R1 to R10	PA	2014 - 2021
ISPRA - Catasto Rifiuti	Special waste management	Non-hazardous waste recovery operation - R12: Exchange of waste to undergo one of the operations listed in R1 to R11	PA	2014 - 2021
ISPRA - Catasto Rifiuti	Special waste management	Non-hazardous waste recovery operation - R13: Putting in reserve	PA	2014 - 2021
ISPRA - Catasto Rifiuti	Special waste management	Operation of recovery of hazardous waste - R1: Main use as a fuel or other means to produce energy	PA	2014 - 2021
ISPRA - Catasto Rifiuti	Special waste management	Hazardous waste recovery operation - R2: Solvent regeneration/recovery	PA	2014 - 2021
ISPRA - Catasto Rifiuti	Special waste management	Hazardous waste recovery operation - R3: Recycling/recovery of organic substances not used as solvents (including composting and other biological transformation operations)	PA	2014 - 2021
ISPRA - Catasto Rifiuti	Special waste management	Hazardous waste recovery operation - R4: Recycling/recovery of metals and metal compounds	PA	2014 - 2021
ISPRA - Catasto Rifiuti	Special waste management	Hazardous waste recovery operation - R5: Recycling/recovery of other inorganic substances	PA	2014 - 2021
ISPRA - Catasto Rifiuti	Special waste management	Hazardous waste recovery operation - R6: Regeneration of acids or bases	PA	2014 - 2021
ISPRA - Catasto Rifiuti	Special waste management	Hazardous waste recovery operation - R7: Recovery of products used to capture pollutants	PA	2014 - 2021
ISPRA - Catasto Rifiuti	Special waste management	Hazardous waste recovery operation - R8: Recovery of products from catalysts	PA	2014 - 2021
ISPRA - Catasto Rifiuti	Special waste management	Hazardous waste recovery operation - R9: Regeneration or other reuse of oils	PA	2014 - 2021

ISPRA - Catasto Rifiuti	Special waste management	Hazardous waste recovery operation - R10: Land spreading for the benefit of agriculture or ecology	PA	2014 - 2021
ISPRA - Catasto Rifiuti	Special waste management	Hazardous waste recovery operation - R11: Utilization of waste obtained from any of the operations listed in R1 to R10	PA	2014 - 2021
ISPRA - Catasto Rifiuti	Special waste management	Hazardous waste recovery operation - R12: Exchange of waste to undergo one of the operations listed in R1 to R11	PA	2014 - 2021
ISPRA - Catasto Rifiuti	Special waste management	Operation of recovery of hazardous waste - R13: Putting in reserve	PA	2014 - 2021
ISPRA - Catasto Rifiuti	Special waste management	Disposal operation of nonhazardous waste - D1: Deposit on or in the ground (e.g., landfill)	PA	2014 - 2021
ISPRA - Catasto Rifiuti	Special waste management	Non-hazardous waste disposal operation - D2: Land treatment (e.g. biodegradation of liquid waste or sludge on soils)	PA	2014 - 2021
ISPRA - Catasto Rifiuti	Special waste management	Nonhazardous waste disposal operation - D3: Deep injection (e.g., injection of pumpable waste into wells, salt domes, or natural geologic faults)	PA	2014 - 2021
ISPRA - Catasto Rifiuti	Special waste management	Non-hazardous waste disposal operation - D4: Laguning (e.g. discharge of liquid waste or sludge into wells, ponds or lagoons, etc.).	PA	2014 - 2021
ISPRA - Catasto Rifiuti	Special waste management	Non-hazardous waste disposal operation - D8: Biological treatment not specified elsewhere in this annex, resulting in compounds or mixtures that are disposed of according to one of the processes listed in D1 to D12	PA	2014 - 2021
ISPRA - Catasto Rifiuti	Special waste management	Non-hazardous waste disposal operation - D9: Physicochemical treatment not specified elsewhere in this annex that results in compounds or mixtures that are disposed of according to one of the	PA	2014 - 2021

		processes listed in D1 to D12 (e.g. evaporation, drying, calcination, etc.)		
ISPRA - Catasto Rifiuti	Special waste management	Non-hazardous waste disposal operation - D10: Incineration on land	PA	2014 - 2021
ISPRA - Catasto Rifiuti	Special waste management	Non-hazardous waste disposal operation - D13: Pre-aggregation before any of the operations in items D1 to D12	PA	2014 - 2021
ISPRA - Catasto Rifiuti	Special waste management	Non-hazardous waste disposal operation - D14: Preliminary reconditioning before any of the operations in D1 to D13	PA	2014 - 2021
ISPRA - Catasto Rifiuti	Special waste management	Non-hazardous waste disposal operation - D15: Preliminary storage	PA	2014 - 2021
ISPRA - Catasto Rifiuti	Special waste management	Hazardous waste disposal operation - D1: Deposit on or in soil (e.g., landfill)	PA	2014 - 2021
ISPRA - Catasto Rifiuti	Special waste management	Hazardous waste disposal operation - D2: Land treatment (e.g. biodegradation of liquid waste or sludge on soils)	PA	2014 - 2021
ISPRA - Catasto Rifiuti	Special waste management	Hazardous waste disposal operation - D3: Deep injection (e.g. injection of pumpable waste into wells, salt domes or natural geological faults)	PA	2014 - 2021
ISPRA - Catasto Rifiuti	Special waste management	Hazardous Waste Disposal Operation - D4: Lagooning (e.g. dumping of liquid waste or sludge into wells, ponds or lagoons, etc.)	PA	2014 - 2021
ISPRA - Catasto Rifiuti	Special waste management	Hazardous waste disposal operation - D8: Biological treatment not specified elsewhere in this annex, resulting in compounds or mixtures that are disposed of according to one of the processes listed in D1 to D12	PA	2014 - 2021
ISPRA - Catasto Rifiuti	Special waste management	Hazardous waste disposal operation - D9: Physicochemical treatment not specified elsewhere in this annex that results in compounds or mixtures that are disposed of	PA	2014 - 2021

		according to one of the processes listed in D1 to D12 (e.g., evaporation, drying, calcination, etc.)		
ISPRA - Catasto Rifiuti	Special waste management	Hazardous waste disposal operation - D10: Incineration on land	PA	2014 - 2021
ISPRA - Catasto Rifiuti	Special waste management	Hazardous waste disposal operation - D13: Pre-aggregation prior to any of the operations listed in items D1 to D12	PA	2014 - 2021
ISPRA - Catasto Rifiuti	Special waste management	Hazardous waste disposal operation - D14: Preliminary reconditioning prior to any of the operations in D1 to D13	PA	2014 - 2021
ISPRA - Catasto Rifiuti	Special waste management	Hazardous waste disposal operation - D15: Preliminary storage	PA	2014 - 2021
ISPRA - Catasto Rifiuti	Production and separate collection of municipal waste	Biowaste - Wet fraction (including domestic composting)	PA	2010 - 2021
ISPRA - Catasto Rifiuti	Production and separate collection of municipal waste	Biowaste - Green	PA	2010 - 2021
ISPRA - Catasto Rifiuti	Production and separate collection of municipal waste	Paper and cardboard	PA	2010 - 2021
ISPRA - Catasto Rifiuti	Production and separate collection of municipal waste	Glass	PA	2010 - 2021
ISPRA - Catasto Rifiuti	Production and separate collection of municipal waste	Wood	PA	2010 - 2021
ISPRA - Catasto Rifiuti	Production and separate collection of municipal waste	Metals	PA	2010 - 2021
ISPRA - Catasto Rifiuti	Production and separate collection of municipal waste	Plastics	PA	2010 - 2021
ISPRA - Catasto Rifiuti	Production and separate collection of municipal waste	WEEE (electrical and electronic equipment)	PA	2010 - 2021
ISPRA - Catasto Rifiuti	Production and separate collection of municipal waste	Textiles	PA	2010 - 2021

ISPRA – Catasto Rifiuti	Production and separate collection of municipal waste	Selective collection	PA	2010 - 2021
ISPRA – Catasto Rifiuti	Production and separate collection of municipal waste	C&D waste (construction and demolition)	PA	2010 - 2021
ISPRA – Catasto Rifiuti	Production and separate collection of municipal waste	Street-cleaning residues, recovered	PA	2010 - 2021
ISPRA – Catasto Rifiuti	Production and separate collection of municipal waste	Bulky waste, recovered	PA	2010 - 2021
ISPRA – Catasto Rifiuti	Production and separate collection of municipal waste	Other	PA	2010 - 2021
ISPRA – Catasto Rifiuti	Production and separate collection of municipal waste	Total separately collected waste	PA	2010 - 2021
ISPRA – Catasto Rifiuti	Production and separate collection of municipal waste	Bulky waste, disposal	PA	2010 - 2021
ISPRA – Catasto Rifiuti	Production and separate collection of municipal waste	Unseparately collected	PA	2010 - 2021
ISPRA – Catasto Rifiuti	Production and separate collection of municipal waste	Total municipal waste	PA	2010 - 2021
ISPRA – Catasto Rifiuti	Production and separate collection of municipal waste	% Separately collected waste	H	2010 - 2021
ISPRA – Catasto Rifiuti	Municipal waste management	Composting - Wet fraction	PA	2015 - 2021
ISPRA – Catasto Rifiuti	Municipal waste management	Composting - Green	PA	2015 - 2021
ISPRA – Catasto Rifiuti	Municipal waste management	Composting - Total municipal waste	PA	2015 - 2021
ISPRA – Catasto Rifiuti	Municipal waste management	Composting - Stludge	PA	2015 - 2021
ISPRA – Catasto Rifiuti	Municipal waste management	Composting - Other	PA	2015 - 2021

ISPRA - Catasto Rifiuti	Municipal waste management	Composting - Total	PA	2015 - 2021
ISPRA - Catasto Rifiuti	Municipal waste management	Integrated aerobic and anaerobic tratment - Wet fraction	I	2015 - 2021
ISPRA - Catasto Rifiuti	Municipal waste management	Integrated aerobic and anaerobic tratment - Green	I	2015 - 2021
ISPRA - Catasto Rifiuti	Municipal waste management	Integrated aerobic and anaerobic tratment - Total municipal waste	I	2015 - 2021
ISPRA - Catasto Rifiuti	Municipal waste management	Integrated aerobic and anaerobic tratment - Stludge	I	2015 - 2021
ISPRA - Catasto Rifiuti	Municipal waste management	Integrated aerobic and anaerobic tratment - Other	I	2015 - 2021
ISPRA - Catasto Rifiuti	Municipal waste management	Integrated aerobic and anaerobic tratment - Total	I	2015 - 2021
ISPRA - Catasto Rifiuti	Municipal waste management	Anaerobic digestion - Organic fraction municipal waste	I	2015 - 2021
ISPRA - Catasto Rifiuti	Municipal waste management	Anaerobic digestion - Stludge	I	2015 - 2021
ISPRA - Catasto Rifiuti	Municipal waste management	Anaerobic digestion - Other	I	2015 - 2021
ISPRA - Catasto Rifiuti	Municipal waste management	Anaerobic digestion - Total	I	2015 - 2021
ISPRA - Catasto Rifiuti	Municipal waste management	Mechanical biological treatment - Unseparately collected waste	I	2015 - 2021
ISPRA - Catasto Rifiuti	Municipal waste management	Mechanical biological treatment - Treated municipal waste	I	2015 - 2021
ISPRA - Catasto Rifiuti	Municipal waste management	Mechanical biological treatment - Other municipal waste	I	2015 - 2021
ISPRA - Catasto Rifiuti	Municipal waste management	Mechanical biological treatment - Total municipal waste and treated municipal waste	I	2015 - 2021

ISPRA - Catasto Rifiuti	Municipal waste management	Mechanical biological treatment - Special waste	I	2015 - 2021
ISPRA - Catasto Rifiuti	Municipal waste management	Incineration - Municipal waste	I	2015 - 2021
ISPRA - Catasto Rifiuti	Municipal waste management	Incineration - Treated municipal waste	I	2015 - 2021
ISPRA - Catasto Rifiuti	Municipal waste management	Incineration - Total municipal waste and treated municipal waste	I	2015 - 2021
ISPRA - Catasto Rifiuti	Municipal waste management	Incineration - Non-hazardous special waste	I	2015 - 2021
ISPRA - Catasto Rifiuti	Municipal waste management	Incineration - Hazardous special waste	I	2015 - 2021
ISPRA - Catasto Rifiuti	Municipal waste management	Co-incineration - Municipal waste	I	2015 - 2021
ISPRA - Catasto Rifiuti	Municipal waste management	Co-incineration - Treated municipal waste	I	2015 - 2021
ISPRA - Catasto Rifiuti	Municipal waste management	Co-incineration - Total municipal waste and treated municipal waste	I	2015 - 2021
ISPRA - Catasto Rifiuti	Municipal waste management	Co-incineration - Treated special waste	I	2015 - 2021
ISPRA - Catasto Rifiuti	Municipal waste management	Co-incineration - Non-hazardous special waste	I	2015 - 2021
ISPRA - Catasto Rifiuti	Municipal waste management	Co-incineration - Hazardous special waste	I	2015 - 2021
ISPRA - Catasto Rifiuti	Municipal waste management	Landfills - Municipal waste	I	2015 - 2021
ISPRA - Catasto Rifiuti	Municipal waste management	Landfills - Treated municipal waste	I	2015 - 2021
ISPRA - Catasto Rifiuti	Municipal waste management	Landfills - Total municipal waste and treated municipal waste	I	2015 - 2021

ISPRA - Catasto Rifiuti	Municipal waste management	Landfill - Special waste	I	2015 - 2021
ISPRA - Catasto Rifiuti	Municipal waste management costs	CRT ab: Costs of collection and transport of unseparately collected municipal waste	I	2011 - 2021
ISPRA - Catasto Rifiuti	Municipal waste management costs	CTS ab: Treatment and disposal costs of unseparately collected municipal waste	I	2011 - 2021
ISPRA - Catasto Rifiuti	Municipal waste management costs	CRD ab: Costs of collection and transport of separately collected municipal waste	I	2011 - 2021
ISPRA - Catasto Rifiuti	Municipal waste management costs	CTR ab: Treatment and recycling costs of separately collected municipal waste	I	2011 - 2021
ISPRA - Catasto Rifiuti	Municipal waste management costs	CSL ab: Road sweeping and washing costs	I	2011 - 2021
ISPRA - Catasto Rifiuti	Municipal waste management costs	CC ab: Common costs	I	2011 - 2021
ISPRA - Catasto Rifiuti	Municipal waste management costs	CK ab: Costs of return on capital	I	2011 - 2021
ISPRA - Catasto Rifiuti	Municipal waste management costs	Other costs: Other costs	I	2011 - 2021
ISPRA - Catasto Rifiuti	Municipal waste management costs	CTOT ab: Total management costs of the urban sanitation service	I	2011 - 2021
ISPRA - Catasto Rifiuti	Municipal waste management costs	CRT kg: Costs of collection and transport of unseparately collected municipal waste	I	2011 - 2021
ISPRA - Catasto Rifiuti	Municipal waste management costs	CRD kg: Costs of collection and transport of separately collected municipal waste	I	2011 - 2021
ISPRA - Catasto Rifiuti	Municipal waste management costs	CSL kg: Street sweeping and street washing costs	I	2011 - 2021
ISPRA - Catasto Rifiuti	Municipal waste management costs	CC kg: Common costs	I	2011 - 2021
ISPRA - Catasto Rifiuti	Municipal waste management costs	CK kg: Return on capital costs	I	2011 - 2021

ISPRA - Catasto Rifiuti	Municipal waste management costs	CTOT kg: Total costs of running the urban sanitation service	I	2011 - 2021
ISPRA - Catasto Rifiuti	Special waste management plants	Composting - Number of plants	I	2011 - 2021
ISPRA - Catasto Rifiuti	Special waste management plants	Composting - Sludge	I	2011 - 2021
ISPRA - Catasto Rifiuti	Special waste management plants	Composting - Other special waste	I	2011 - 2021
ISPRA - Catasto Rifiuti	Special waste management plants	Composting - Total special waste	I	2011 - 2021
ISPRA - Catasto Rifiuti	Special waste management plants	Integrated aerobic and anaerobic treatment - Number of plants	I	2011 - 2021
ISPRA - Catasto Rifiuti	Special waste management plants	Integrated aerobic and anaerobic treatment - Sludge	I	2011 - 2021
ISPRA - Catasto Rifiuti	Special waste management plants	Integrated aerobic and anaerobic treatment - Other special waste	I	2011 - 2021
ISPRA - Catasto Rifiuti	Special waste management plants	Integrated aerobic and anaerobic treatment - Total special waste	I	2018 - 2021
ISPRA - Catasto Rifiuti	Special waste management plants	Anaerobic digestion - Number of plants	I	2018 - 2021
ISPRA - Catasto Rifiuti	Special waste management plants	Anaerobic digestion - Sludge	I	2018 - 2021
ISPRA - Catasto Rifiuti	Special waste management plants	Anaerobic digestion - Other special waste	I	2018 - 2021
ISPRA - Catasto Rifiuti	Special waste management plants	Anaerobic digestion - Total special waste	I	2018 - 2021
ISPRA - Catasto Rifiuti	Special waste management plants	Mechanical biological treatment - Number of plants	I	2018 - 2021
ISPRA - Catasto Rifiuti	Special waste management plants	Mechanical biological treatment - Special waste	I	2018 - 2021

ISPRA - Catasto Rifiuti	Special waste management plants	Co-incineration - Number of plants	I	2018 - 2021
ISPRA - Catasto Rifiuti	Special waste management plants	Co-incineration - Combustible waste (EER 191210)	I	2018 - 2021
ISPRA - Catasto Rifiuti	Special waste management plants	Co-incineration - Other non-hazardous special waste	I	2018 - 2021
ISPRA - Catasto Rifiuti	Special waste management plants	Co-incineration - Hazardous special waste	I	2018 - 2021
ISPRA - Catasto Rifiuti	Special waste management plants	Co-incineration - Total special waste	I	2018 - 2021
ISPRA - Catasto Rifiuti	Special waste management plants	Landfills - Number of plants	I	2018 - 2021
ISPRA - Catasto Rifiuti	Special waste management plants	Landfills - Non-hazardous waste	I	2018 - 2021
ISPRA - Catasto Rifiuti	Special waste management plants	Landfills - Hazardous waste	I	2018 - 2021
ISPRA - Catasto Rifiuti	Special waste management plants	Landfills - Total special waste	I	2018 - 2021
ISPRA - Catasto Rifiuti	Special waste management plants	Vehicle breakers (Legislative Decree 209/2003) - Number of plants	I	2018 - 2021
ISPRA - Catasto Rifiuti	Special waste management plants	Vehicle breakers (Legislative Decree 209/2003) - Vehicles	I	2018 - 2021
ISPRA - Catasto Rifiuti	Special waste management plants	Scrappers vehicles (Legislative Decree no. 209/2003) - Number of plants	I	2018 - 2021
ISPRA - Catasto Rifiuti	Special waste management plants	Scrappers vehicles (Legislative Decree no. 209/2003) - Vehicles (EER 160106)	I	2018 - 2021
ISPRA - Catasto Rifiuti	Special waste management plants	Scrappers vehicles (Legislative Decree no. 209/2003) - Other special waste	I	2018 - 2021
ISPRA - Catasto Rifiuti	Special waste management plants	Scrappers vehicles (Legislative Decree no. 209/2003) - Total	I	2018 - 2021

ISPRA - Catasto Rifiuti	Special waste management plants	Vehicle crushers (Legislative Decree no. 209/2003) - Number of plants	I	2018 - 2021
ISPRA - Catasto Rifiuti	Special waste management plants	Vehicle crushers (Legislative Decree no. 209/2003) - Vehicles (EER 160106)	I	2018 - 2021
ISPRA - Catasto Rifiuti	Special waste management plants	Vehicle crushers (Legislative Decree no. 209/2003) - Other special waste	I	2018 - 2021
ISPRA - Catasto Rifiuti	Special waste management plants	Vehicle crushers (Legislative Decree no. 209/2003) - Total	I	2018 - 2021

2.1.3 Data micro level

Data on Circular Economy in Italy is available from surveys, but it is not exhaustive and does not cover all sectors. However, we can still highlight some of the principal results.

A survey conducted by Legambiente & Ipsos in 2023[8], titled "Italy and the Circular Economy," revealed important insights into Italian citizens' perceptions about circular economy. The results indicated that the awareness of circular economy principles is expected to increase by 2023, and the number of experts in this field is also expected to grow. The survey also highlighted the fact that while Italians understand the importance of reusing and recycling materials, they lack awareness of certain aspects of environmental conservation. For instance, only 2 out of 10 Italians consider used mineral oil to be regenerable, and half of them are not familiar with the methods of treating used mineral oil. However, once they are informed that used mineral oil can be completely regenerated and reused, almost half of Italians see the potential to support the country's energy independence.

Another survey conducted by Legacoop & Ipsos in 2023[9] aimed to determine the level of circularity in consumption choices and attitudes towards the Circular Economy. The survey focused on various topics such as leasing, renting, and sharing; refurbished or restored products; purchase, use, and circular economy; packaging and sustainability; product life cycle; and giving products a second life. The results showed that almost half of the respondents (45%) had purchased a used product in the last three years, whereas 36% had bought a reconditioned or regenerated product. Interestingly, the survey also

[8] https://www.legambiente.it/wp-content/uploads/2021/11/Report-Ipsos-Ecoforum-2023.pdf

[9] https://circulareconomynetwork.it/wp-content/uploads/2023/05/SONDAGGIO-COOP-1.pdf

revealed that consumers were hesitant to buy remanufactured or used products, with only a mild inclination to repair.

To increase awareness of the circular economy among citizens, the Italian Institute for Environmental Protection and Research (ISPRA) has launched a national survey. This initiative is the first step of a campaign in which the three entities involved will carry out information, communication, awareness, and training actions. These actions are aimed at businesses, associations, media, schools, citizens, and consumers. Anyone who has implemented practical measures to raise awareness among citizens and consumers can participate and promote their good practices.

A study conducted in 2016 by Bureau Veritas Italia, AISEC, and Università Cattolica di Milano[10] focused on assessing Italian companies' readiness for circular economy practices. The survey results showed that 91.07% of companies were willing to adopt a circular economy model, and 63.40% believed they had already initiated the process towards circularity. However, the survey also revealed that many companies faced significant barriers to implementing these practices, such as the lack of networks and funds. Despite this, some companies had already taken steps towards circularity, such as monitoring energy, water, and polluting emissions consumption, saving energy and greenhouse gas emissions, waste valorisation, product life cycle, social projects, and partnerships.

Antonioli et al. (2022) conducted a study on how companies can adapt in different ways to the challenges of transitioning to a circular economy, and become successful innovators in the field. The study is based on a survey of targeted manufacturing companies with at least 10 employees across the country. Results show that structures play a crucial role suggesting that firms with high employee involvement, well-qualified human capital, and rewarding schemes for good employee performance are more likely to be successful circular innovators than their peers.

In 2015, CRIET (Università Milano-Bicocca) collaborated with IPSOS to conduct a survey on Italian companies' approach towards circular economy[11]. The results showed that the concept of sustainability is gaining importance among Italian businesses and it is likely to have a huge impact on their operations in the future. However, despite the increasing popularity of circular economy, Italian companies still have a limited understanding of its potential benefits. Presently, circular economy is mostly considered as an effective practice for environmental sustainability, and its full potential remains untapped. Due to the lack of specific knowledge about the advantages of this model, companies are yet to fully realize its potential for gaining a competitive edge. However, some companies

[10] https://altis.unicatt.it/altis-BVI-Presentazione_Survey_rev2605.pdf

[11] https://criet.unimib.it/wp-content/uploads/2015/03/20150319EconomieCircolariADGNG.pdf

have already started to reap the benefits of reduced costs and employment, although consumers still appear to be largely unreceptive. Based on this survey, a cross-country analysis was conducted on Italy and France[12]. The study revealed that Italy and France share the fundamental elements of a circular economy, but France seems to have a better grasp of the concept. Furthermore, circular economy is gaining traction in both countries, but it is more widespread in France than in Italy. In Italy, circular economy is mostly seen as a good practice for environmental sustainability, while its economic potential is often overlooked. On the other hand, in France, the benefits of circular economy are more evident both internally and externally to the company, and French consumers and stakeholders show a greater sensitivity to the concept.

It is important to highlight the ongoing CERES[13] survey at the European level. The survey is part of a European project that aims to identify the professional roles and skills required by companies to fully embrace the circular model. The project investigates the level of awareness linked to the circular economy, the willingness to move towards it, and the potential obstacles that may arise. The ultimate goal is to effectively address the challenges of transitioning to a circular economy and to align with the transformations that the world of work will inevitably undergo in the context of the European Green Deal. The survey will be sent to European companies and the findings will be used to produce a report, outlining the needs of various sectors in the countries involved in the project.

2.2. Regional indicators from a broad perspective

Regional CE transition needs the contribution of different groups of economic actors (households, public administration, industries). These dimensions are related among them. Indeed, regional CE transition is affected by regional specialization, but this could be positively or negatively moderated by the regional context (i.e., how households and public administration are in favour or not of this transition).

The previous section reported a list of CE regional indicators grouped into 3 categories: households (Indicator 1), public administration (Indicator 2), and industries (Indicator 3). In the next steps, the research will aim to provide synthetic measures of the regional CE transition in Italy, isolating the contribution of each group of actors (see Figure 2.1).

In particular, we need to focus on the supply-side (industries) in order to observe how regional specialization is connected to CE transition. This would allow making an evaluation of potential risks and opportunities of regional structural change.

[12] https://criet.unimib.it/wp-content/uploads/2015/11/20151125EventiCRIETIncontraEconomieCircolariADGNG.pdf

[13] https://criet.unimib.it/wp-content/uploads/2015/03/20150319EconomieCircolariADGNG.pdf

This investigation could be strictly connected to the issue of regional cohesion. Indeed, as suggested by Rodriguez-Pose and Bartalucci (2023), the impact of green transition may unevenly involve regions with economic structure, and this may dramatically increase regional economic divergence in Europe. The Authors say: "*… a critique that is often directed at existing analyses of the green transition is the absence of a context, which may lead to the erroneous conclusion that sustainability can take place anywhere through similar process*" (p. 1). Similarly, one can erroneous conclude in the case of CE transition.

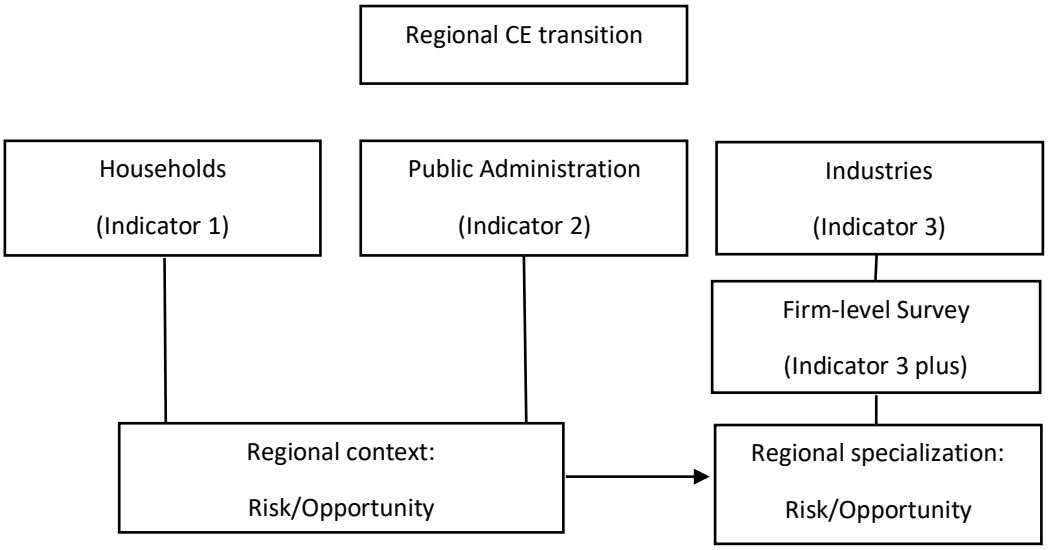


Figure 2.1 – Regional CE transition

However, as it emerged from the previous sections, Italian regional data at industrial level on the issue of CE transition are very limited to green resources used (upstream) or green production realized (downstream). There is instead a lack of information on what happens during the process of production (e.g., technology, innovation, employees' skills, etc.) All information that would allow a more accurate evaluation of risk and opportunities connected to the regional structural changes and that can be obtained only collecting new data at micro-level (Indicator 3 plus).

2.3. Regional indicators of risks and opportunities of structural change towards circular innovations: a micro-founded approach

In this document, we introduced a wide range of statistical information available in Italy on the issue of CE transition. We can note a particular lack of data from the supply-side, notwithstanding some novel surveys aimed producing information at firm-level but mostly based on small samples that are not suitable for understanding the transition at regional and industrial level. In other words, there is still limited information available reading progress and actual implementation of CE practices by Italian firms, industries, and regions. We need a larger sample of firms to understand risks and opportunities of regional structural change towards CE transition.

To this end, we propose to collect information on about 20,000 firms with at least 10 employees sampled by a stratification at regional and industrial level. In particular, the questionnaire will be structured into five sections as follows:

(i) General characteristics of respondents
(ii) Circular Economy transition and innovation
(iii) Circular Economy transition and labour market
(iv) Circular Economy transition and global dynamics
(v) Circular Economy transition and regional policies

This survey will allow to investigate risks and opportunities of CE transition from different perspective (technology and innovation, labour market, international market, regional specialization and public financing) (see Figure 2).

Section (i) includes all the basic information on the firm (size, sector, geographical location, age, etc.) and on the top manager (age, gender, education, experience, etc.). This allows to have a rich set of control variables useful for an accurate identification of the parameters of interest.

Section (ii) looks more in detail at innovations and technologies for the CE transition, distinguishing between different sources of knowledge (internal and external to a firm) and different type of innovation (technological and non-technological) as well as technologies employed (e.g., artificial intelligence).

Section (iii) focuses on the labour market and the specific profiles of employees for the CE transition. The aim is to understand the potential skills mismatch in firms and territories that may be represent a barrier to the CE transition.

Section (iv) looks at the international market as opportunity or risk for CE transition. This section allows to evaluate the potential reconfiguration of global value chains engendered by the diffusion of CE practices.

In Section (v), the survey focuses on risks and opportunities associated with specific regional contexts. Additionally, the section will consider the role of public funding at regional, national and European level.

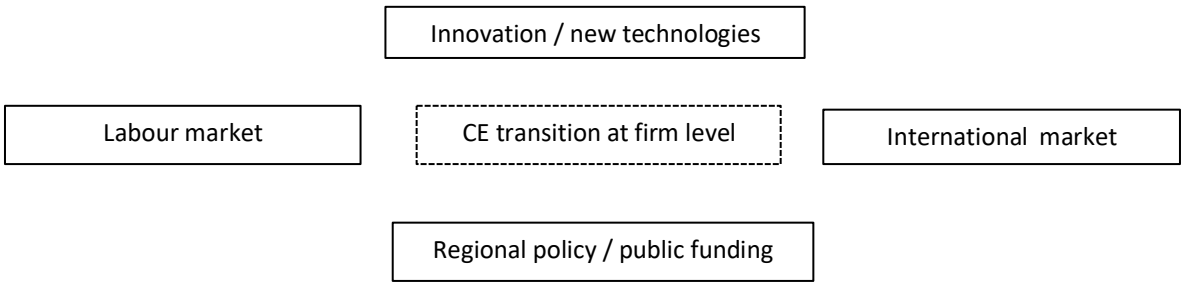


Figure 2.2 – CE transition firm-level survey structure

This will represent the most exhaustive source of information on the CE transition in Italy at firm, industry and regional level. This will allow to have a reliable picture of the phenomenon and to adapt policies with respect to different regional and industrial features.

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Annex 1: List of monitoring frameworks (OECD)

Colombia	National Strategy for the Circular Economy (2019)
European Union France	Monitoring Framework for the Circular Economy (2019)
France	10 Key Indicators for Monitoring the Circular Economy (2017)
Italy	Towards a Model of Circular Economy for Italy - Overview and Strategic Framework (2017) Circular Economy: What We Want to Know and Can Measure (2018)
Netherlands	Circular Economy: What We Want to Know and Can Measure (2018)
Portugal	Leading the Transition [Action Plan for a Circular Economy in Portugal: 2017-2020] (2017) Roadmap Towards the Circular Economy in Slovenia (2018)
Slovenia	Roadmap Towards the Circular Economy in Slovenia (2018)
Spain	Spanish Strategy for Circular Economy: España Circular 2030 (2020)
Basque Country (Spain) Brussels-Capital Region (Belgium) Catalonia (Spain)	Basque Country Circular Economy Strategy 2030 (2019)
Brussels-Capital Region (Belgium)	Regional Programme for the Circular Economy 2016 – 2020 (PREC) (2016)
Catalonia (Spain)	Promoting the Green and Circular Economy in Catalonia (2015)
Extremadura (Spain)	Extremadura 2030. Green and Circular Economy Strategy (2018)
Galicia (Spain)	Galician Strategy of Circular Economy 2019-2030 (2019)
Navarre (Spain)	Agenda for the Development of the Circular Economy in Navarra 2019-2030 (2019) Roadmap of the Circular Economy of North Karelia (2018)

North Karelia (Finland)	Roadmap of the Circular Economy of Noth Karelia (2018)
Scotland (UK)	Making Things Last A Circular Economy Strategy for Scotland (2016)
Ambsterdam	Circular Amsterdam – A Vision and Action Agenda for the City and Metropolitan Area (2016) The Green and Circular Economy of Barcelona City Council (2019)
Barcelona (Spain)	The Green and Circular Economuy of Barcelona City Counsil (2019)
Bilbao	Circular Bilbao and Bizkaia (2018)
Greater Porto Area (Portugal)	Circular Economy Framework Monitoring Report (NA)
Paris (France)	Paris Circular Economy Plan: 2017-2020 (2017)
Paris (France)	1st Roadmap Paris Circular Economy Plan (2017)
Paris (France)	2nd Roadmap Paris Circular Economy Plan (2018)
Peñaloén (Chile)	Inclusive Recycling Programme (2013)
Peterborough (UK)	Measuring the Circular Economy: Developing an Indicator Set for Opportunity (2018) Circular Economy Procurement Implementation Plan and Framework (2018)
Turku (Finalnd)	Resource Wisdom Roadmap