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Report on experiences with the implementation of Circular Economy outside Europe

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Summary

This report provides an overview of current R&I priorities in extra European countries, expressed in running and newly introduced funding and legislative measures with respect to Circular Economy. Chapter 1 introduces the methodology and the survey response; The survey results on the funding for CE are presented in Ch. 2 for European cooperation in an international context; for International organisations in Ch.3; in selected industrial Countries in Ch.4; in selected BRICS Countries in Ch.5; in selected developing Countries in Ch.6; Ch.7 presents the results on CE related activities including strategic eco-political positioning in the secondary materials supply sector that determine especially key technologies; Ch.8 presents selected examples of valuable experiences and lessons learnt. Data on 35 CE funding programmes and supporting measures from 3 European organisations, 6 international organisations and 30 countries were obtained. R&I programmes for CE in extra European countries overwhelmingly consist of national programmes with a volume of less than 1 million and duration of 4 years. The focus is on waste, water and chemicals, and on end-of-life phase, manufacture and second life. The major type of funding addresses technology & process optimisation, the most frequently beneficiary types are companies from water, waste and manufacturing sectors. The programmes are mostly addressing the highest Technology Readiness Level scaling (TLR 9) or referred to field pilots (TLR 5-6). Recently numerous legislations on CE have been promulgated around the world. It resulted of rewording or widening the approach of former strategies. Networks & clusters, industry, academia, administration, and civil society have been identified in most countries. Networks bring stakeholders along the life cycle together and seem to play a very significant role. The level of alignment with CE European definition is high in all industrial and BRICS countries apart from South Africa and in more than half of the developing countries considered. Ch.7 provides the results of the D1.3 attached report reviewing the most challenging technology developments in the secondary raw materials economy outside of Europe that influence and impact emerging technology sectors in Europe.

Approval

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Final draft

EXECUTIVE SUMMARY

The objective of this report is to provide a concise overview of current R&I priorities in extra European countries and regions, expressed in running and newly introduced funding and legislative measures with respect to Circular Economy.

Chapter 1 introduces the methodology and the survey response; Chapter 2 presents the survey results on the funding for CE in the frame of European cooperation in an international context; Chapter 3 presents the survey results on the funding for CE in International organisations; Chapter 4 presents the survey results on the funding for CE in selected industrial Countries; Chapter 5 presents the survey results on the funding for CE in selected BRICS Countries; Chapter 6 presents the survey results on the funding for CE in selected developing Countries; Chapter 7 presents the results on CE related activities including strategic eco-political positioning in the secondary materials supply sector that determine especially key technologies; Chapter 8 presents selected examples of valuable experiences and lessons learnt.

The survey is based on data collected by questionnaires, which were distributed among six CICERONE project partners assigned responsible for the data collection in specific organisations or countries.

In total, data of 3 European organisations, 6 international organisations and 30 countries were obtained representing altogether 35 CE funding programmes and further supporting measures. These programmes were described in detail along 19 survey questions by the project partners on desktop basis.

Based on the assessment of 35 R&I programmes identified in 30 countries, the results can be summarised as follows:

At present, the R&I programmes for CE in extra European countries overwhelmingly consist of national programmes with a volume of less than 1 million and duration of 4 years. The focus is predominantly on the resources flows “waste”, “water” and “chemicals”, and the most frequently addressed product life cycle phases are “end-of-life phase”, “manufacture” and “second life”.

The major type of funding is predominantly addressed to technology and process optimisation and the most frequently beneficiary types are “companies” from the “water & waste sector” and “manufacturing” sectors. Regarding the Technology Readiness Levels (TRL), the programmes are mostly addressing the highest level “scaling” (TLR 9) or referred to “field pilots” (TLR 5-6).

Objectives of organisations and countries analysed are mainly “economic” and “societal” and while key performance indicators show a focus on “ecological” targets. There is no clear explanation for this finding.

No collaboration between funding programmes has been identified in the 30 extra European countries considered.

Recently numerous legislations on Circular Economy have promulgated around the world. In some cases, this was the consequence of a rewording or focussing of former strategies e.g. for Green growth, Green economy or Resource efficiency. In other cases, it was a widening of the topic addressed mainly waste and water management to the broader circular approach. This observation has been made for different continents and different kind of countries (industrial, developing or BRICS countries).

The country-specific trends in technology development identified in industrial and BRICS countries are very similar to those described for Europe in CICERONE report D1.2 while the focus in most developing countries is clearly on water and waste management. The same remark can be made for the country-specific trends in circular business fields with a high interest in repair shops in the three Latin American countries analysed.

Actors like networks, clusters and associations, industry, academia, administration, civil society have been identified in most countries. The first category “Networks, clusters and associations” brings stakeholders along the life cycle together and seem to play a very significant role on all continents.

The level of alignment with CE European definition seems to be very high or high in all industrial and BRICS countries apart from South Africa. More than half of the developing countries considered have a similar high level of alignment. In comparison with the results of the European Benchmark (CICERONE report D1.2) following similarities and differences have been identified:

Similarities:

- “National funding programmes” are predominating
- “Waste” is the most common resource addressed
- The “End-of-life phase” is the most common one
- The major type of funding is “Technology and process optimisation”
- The most frequently beneficiary are “Companies” from “Manufacturing”, “Water” and “Waste” sectors
- The Technology Readiness Levels “Fields pilots” (TRL 5-6) and “Market introduction” (TRL 7-8) are commonly addressed
- “Ecologic” and “Economic” targets are very common

Differences in international context versus European context:

- The budget per project is lower
- The project duration is longer
- “Water” and “chemicals” are also addressed very often
- Other product life cycle phases are well addressed: “Manufacture” and “Second life”
- “Non-profit organisations” are much more often beneficiaries
- The most common Technology Readiness Level is much higher: Scaling (TRL 9)
- “Societal” targets are more common.

Chapter 7 provides the results of the D1.3 attached report reviewing the most challenging technology developments in the secondary raw materials (RM) economy outside of Europe that influence and impact emerging technology sectors in Europe. Although each commodities studied in the report have its own specific challenges, recurrent themes can be found such as requiring processing technologies which accept diverse material feeds, and which recovers multi-elements as by-products.

Metallurgical infrastructures are indispensable for enabling CE. However, with only four out of 66 new installations worldwide, the EU investment in this field is not outstanding considering the EU’s aim to achieve CE in the near future. Political interventions, such as the REACH and specifically lead and copper bans, also challenge producers and recycling companies in the same way. In many cases, production and recycling processes need to be adjusted hard on the limit to economic viability. A principle problem being regarded by many smelting companies is that more and more politics and policies pose production processes and materials supply challenges and the challenges do not always lead to new and more competitive niche inventions.

KEYWORDS

Circular economy, research & innovation, extra European Countries, industrial countries, BRICS countries, developing countries, SRIA, secondary raw materials supply.

Final draft

1 OBJECTIVES OF THE EVALUATION AND METHODOLOGICAL APPROACH

The CICERONE project brings together programme owners, research organisations and other stakeholders to create a platform for efficient Circular Economy programming. The priority setting and the organisation of the future platform is driven by Programme Owners (POs), involved either as project partners, or via a stakeholder network.

1.1 OBJECTIVES

Within the project, WP 1 aims to generate an understanding for CE in terms of its societal challenge, industrial relevance, R&I policy, and trends in technology developments using as far as possible relevant available reports. It compiles and analyses the status quo regarding the emergence of circular economy and affiliated strategies and policy making in the European Union and outside Europe. European Benchmark has been addressed in Deliverable 1.2.

The key objective of this deliverable D 1.3 International Benchmark is to gain insights on and assess how CE is being implemented and possibly R&I is being funded in following cases:

- European cooperation in an international context,
- International organisations,
- Industrial and developing Countries, BRICS Countries have been treated separately,
- Screening of countries for their CE related activities including strategic eco-political positioning in the secondary materials supply sector that determine especially key technologies.

There was no claim to completeness but the real objective to identify and analyse succinctly the most interesting experiences and lessons learnt, successful or not. The objective of this report is to provide examples of current initiatives supporting Circular Economy, especially R&I funding programmes outside Europe.

The survey was conducted with support and data provision of several CICERONE projects partners where the single projects partners were assigned responsible for one or more countries or organisations.

This deliverable is structured as follows:

Chapter 1 introduces the methodology and the survey response.

Chapter 2 presents the survey results on the funding for CE in the frame of European cooperation in an international context.

Chapter 3 presents the survey results on the funding for CE in International organisations.

Chapter 4 presents the survey results on the funding for CE in selected industrial Countries.

Chapter 5 presents the survey results on the funding for CE in selected BRICS Countries.

Chapter 6 presents the survey results on the funding for CE in selected developing Countries.

Chapter 7 presents the survey results on CE related activities including strategic eco-political positioning in the secondary materials supply sector that determine especially key technologies.

Chapter 8 presents selected examples of valuable experiences and lessons learnt.

1.2 METHODOLOGY

The survey is based on data collected via a questionnaire which was forwarded to the CICERONE project partners assigned responsible for the data collection in specific countries or other international context, according to the proposal Work Package 1 (WP1). An overview of the distribution of work among the partners is given in Table 15 in the Annex 1. This distribution is the result of discussions between the task partners that took place in February.

As JUELICH and GKZ were involved in the development of the draft questionnaire for the investigation of the actual R&I priorities for the Circular Economy in European countries and regions for Deliverable 1.2, the European questionnaire was adapted to an International one. Specific European issues, e.g. RIS2 Strategy, have been deleted, while new points, e.g. country context, have been added.

The data collection was kicked-off on 20th February 2019 with a return period of 4 weeks. Due to long exchange with project partners from WP1 and other work packages the templates were completed by mid of June.

The data collection sheet contains four clusters of questions (see ANNEX 2). The complex “Funding for CE” comprises 16 questions and asks for maximum five programmes or initiatives of the most important CE (framework) funding programmes in the various countries to be described in detail along these questions. The cluster is a mixture of open and closed questions. A second focus is put on “R&I stakeholders”, where country managers were asked to provide up to 10-15 contacts. These data are sensitive and are not going to be presented in this report. Rather, they are important for subsequent work packages and workshops and therefore only handled internally.

In order to get an impression of current developments in legislation, the question complex “Legislation for CE” asks respondents to provide 2-3 national examples of legislative measures which are considered triggering R&I for CE from 2015 onwards. The fourth complex finally asks for “R&I priorities” with clear CE implications on a circular economy and provides space for open answers concerning country-specific trends in technology development and business fields.

For organisations as well for countries the objectives for supporting CE, the main findings and the conclusion including level of alignment to CE based on European Definition.

For communicating our understanding on the level of alignment of countries to Circular Economy based on European Definition, a scoring system from ‘0’ to ‘3’ was proposed by Sonia Valdivia (WRFA):

- ‘0’ for no alignment
- ‘1’ for alignment with a very limited scope, or very weak alignment with very little or no impact (yet) on circularity
- ‘2’ for partial alignment in private and/or public initiatives with some impact on circularity
- ‘3’ for extensive alignment in private and public initiatives with visible impact on circularity

If needed intermediate score e.g. 1,5 can be attributed. This scoring gives a short overview of the actual situation based on the information collected.

1.3 SURVEY RESPONSE

In total, data of 30 countries and 5 organisations were obtained (see Table 1). 45 funding programmes have been described. Taking into consideration the fact that for 11 developing countries cooperating with Italy ("Italy Group"), a unique Italian national programme has been considered, the real number of different programmes described is 35.

Industrial countries were represented by Australia, Japan, South Korea, Taiwan and the USA. Three "BRICS Countries" have been analysed: India, People's Republic of China and South Africa. Fourteen developing countries were considered, eleven of them in the frame of cooperation with Italy.

Table 1: Organisations and countries responses (number of programmes described)

European International Cooperation	International Organisations	Industrial Countries	BRICS Countries	Developing countries
European Commission (3)	G7/G20 (2)	Australia (3)	India (5)	Colombia (1)
European Investment Bank (1)	OECD (1)	Japan (2)	People's Republic of China (3)	Ecuador (3)
German Federal Ministry for Education & Research (1)	United Nations (3)	South Korea (5)	South Africa (3)	Peru (3)
	WRFA (1)	Taiwan (2)		Botswana, Cuba, Djibouti, Eswatini, Ethiopia, Iran, Lesotho, Maldives, Pacific Ocean Small Insular Countries, Sudan, Union of Comoros (1)*
		USA (4)		
5	7	16	11	8
12		35		

Legend: *The same Italian national funding programme is described for all these countries

The main objective of this deliverable was not to compare organisations with countries or even countries among them but to provide examples of current initiatives supporting Circular Economy.

1.4 CLUSTERING THE OBJECTIVES ADDRESSED BY PROGRAMMES OWNERS

In order to cluster the main objectives addressed by programmes owners from both organisations and countries six main objectives have been identified out of the survey results (see Table 2).

Table 2: Clustering the objectives addressed by the programmes

Improve waste management	Reduce resources consumption / sustainable production	Climate protection	Support economic growth	Protect the environment	Establish a Circular society / Education / Dialogue

2 EUROPEAN COOPERATION IN AN INTERNATIONAL CONTEXT

2.1 OBJECTIVES

The following programmes and stakeholders relevant to European international cooperation regarding the Circular Economy have been identified:

- “Circular Economy Missions to Third Countries”, European Union Commission
- Horizon 2020 – Program, European Union Commission
- COST- Program, European Union Commission
- Circular Economy Guide, European Investment Bank (EIB)
- CLIENT/ CLIENT II, as an example for bilateral cooperation between EU-countries and non-EU-countries. More examples of bilateral cooperation between EU-countries and non-EU-countries can be found in the chapter Developing countries (see chapter 6).

The programmes implemented by the European Commission, the European Investment Bank and the German Federal Ministry for Education & Research (as an example for Bilateral European-International funding programme on Circular Economy) have the following main objectives in common:

- support the transition to a circular economy within the EU and in other parts of the world
- support cooperation between EU-countries and non-EU-countries within the field of circular economy, connect different stakeholders in the field of circular economy within the EU and internationally and create networks where partnerships between stakeholders from research, innovation, business and industry and other practitioners can be developed
- strengthen Europe’s capacity to address scientific, technological and societal challenges
- foster interdisciplinary research

All these objectives contribute to the objective “Establish a Circular society / Education / Dialogue” (see Table 3).

Table 3: Objectives from programme owners involved in European international cooperation

Objectives	Improve waste management	Reduce resources consumption / sustainable production	Climate protection	Support economic growth	Protect the environment	Establish a Circular society / Education / Dialogue
EU Commission	X	X	X	X	X	X
European Investment Bank	X	X	X	X	X	X
German Federal Ministry for Education & Research	X	X	X	X	X	X

Moreover, these programme owners address with their activities all other objectives identified in the survey results (see chapter 1.4).

2.2 MAIN FINDINGS

The identified programme initiatives are connected to one another and cannot always be clearly separated. However, in the following each programme/stakeholder will be described briefly:

2.2.1 “Circular Economy Missions to Third Countries” of the European Union Commission

The “Circular Economy Missions to Third Countries” of the European Union Commission operate on a supra-national level. Starting in April 2016, six missions to Chile, China, South Africa, Colombia, Japan, Indonesia and India have been achieved until today. For the future mission to Mexico, Singapore and Malaysia are being planned. Many stakeholders, especially green European businesses, including SMEs who are planning to expand their activities abroad, are expected to benefit from the missions.

The “Circular Economy Missions to Third Countries” of the European Union Commission, focus mostly on the topics of eco-innovation, marine pollution and urban environmental best practices. The main objective is to increase the cooperation between the EU and third countries in the field of environmental policy. Therefore, the following objectives need to be reached:

- to sign political agreements directed at fostering the circular economy, green public procurement and innovative, sustainable and inclusive growth,
- to achieve a better understanding of the environmental challenges faced by third countries
- to promote green solutions through business partnerships abroad (In this regard, the missions will organize matchmaking events between European and local entrepreneurs and will engage in exchange of views with targeted audiences)

The policies discussed during the missions gravitate around circular economy, resource efficiency and sustainable use of natural resources. These issues offer a wide area for further bilateral discussions, not least because they have a great potential for innovative business solutions. For instance, the use of state-of-the-art technologies can help to reduce environmental impacts.

2.2.2 Horizon 2020 – Programme

Horizon 2020 is the financial instrument (and largest EU Research and Innovation programme ever) implementing the Innovation Union, a Europe 2020 flagship initiative aimed at securing Europe's global competitiveness. The Horizon 2020-Program focusses on four different areas. One of these focus areas is called 'Connecting economic and environmental gains – the Circular Economy' has is going to run from 2018 – 2020.

The identified project examples LIMPID, SHAREBOX and ProSUM focusing on circular economy will run for two to seven years.

A special funding scheme within Horizon 2020 is the ERA-NET. ERA-NET *“aims at developing and strengthening the coordination of national and regional research programme. Under the ERA-NET scheme, national and regional authorities, represented by so-called 'programme owners' and/or 'programme managers', identify research programme they wish to coordinate or open up mutually. The focus and role of ERA-NETs has varied across the Frameworks Programs.”* [1]

As shown on Table 4 some ERA-NETs (and similar funding schemes like ERA-NET Cofund) implemented in the frame of Horizon 2020 address Circular Economy are involving extra European countries. International parts are industrial countries, developing countries as well as BRICS countries.

Table 4: Selected ERA-NETs addressing Circular Economy and involving extra European countries

Acronym	Full Title	Extra European countries
WaterWorks2017	Closing the water cycle gap	Argentina, Brazil, Canada, Egypt, South Africa, Taiwan, Tunisia, Vietnam
EN-SUGI	Eranet Sustainable Urbanisation Global Initiative	Argentina, Brazil, Japan, Qatar, Taiwan, USA
M-ERA.NET 2	ERA-NET for materials research and innovation	Brazil, Canada, Korea, Russia, South Africa, Taiwan
PRIMA	Partnership for Research and Innovation in the Mediterranean Area	Algeria, Egypt, Jordan, Lebanon, Tunisia
MarTERA	Maritime and Marine Technologies for a New ERA	Argentina, Belarus, South Africa
ERA-MIN2	Implement a European-wide coordination of research and innovation programmes on raw materials to strengthen the industry competitiveness and the shift to a circular economy	Argentina, Brazil, Chile, South Africa

As they are H2020 partners Turkey and Israel are not considered as “extra European Countries”

Examples of European funding older than Horizon 2020 are given for following countries: India (SWITCH ASIA SCP), South Africa (SWITCH AFRICA GREEN)

2.2.3 COST- Programme

COST (European Cooperation in Science and Technology) is a funding organization for research and innovation networks that provides networking opportunities for researchers and innovators in order to strengthen Europe’s capacity to address scientific, technological and societal challenges.

There are 206 ongoing cost actions in total, three of these actions are focused on circular economy and have participants that are not part of EU: Circular City Re.Solution, AEROGELS, SOURDOMICS. The three projects are running for four years from 2018 to 2022. [2]

2.2.4 European Investment Bank

The European Investment Bank is the world’s largest multilateral lender and the biggest provider of climate finance. The EIB has published a Circular Economy Guide that lists 11 examples for CE related project funded by the EIB. However, only one project involves stakeholders from the EU as well as from other parts of the world, the “Mauritius Sugar Reform Project”. [3]

2.2.5 Bilateral cooperation example: CLIENT I & II Programme

The bilateral funding programme CLIENT II (Germany, represented by the Federal Ministry for Education and Research “BMBF” and funding partners from developing countries) runs from 2016 to 2023 as the follow-up programme to CLIENT I.

“The programme aims to support international partnership in the areas of climate, environment and energy. CLIENT II puts a spotlight on demand-oriented research and development collaborations with select newly industrializing and developing countries with interesting markets for German suppliers of

technology. The programme funds joint research and development (R&D) projects carried out by research institutions, industry and other practitioners". [4]

In 2016 CLIENT II has been funding eight projects in the area of resource efficiency and sustainable resource technology with 12.1 Mio €. In 2017 nine projects in the same area have been funded by CLIENT II with 11.3 Mio €. [4]

Further examples of bilateral programme are given for following countries: Colombia, Peru and the "Italian Group" of countries (see Table 12).

2.2.6 Resource Flow addressed & project examples

The identified programme fund research and innovation projects, which in most cases cover all product life cycle phases. Depending on the project different resource flows are being focused on. As the idea of Circular Economy suggests, projects often combine different resource flows. In Table 5 examples have been assigned to a main resource-flow-group:

Table 5: Project examples incl. programmes and resources flow addressed

Resource flow	Programme	Project examples
Minerals	Horizon 2020	ProSUM, ERA-MIN2
Metals	Horizon 2020	ERA-MIN2
Biomass		
Water	Horizon 2020	LIMPID, WaterWorks2017
	CLIENT II	Pirate Systems
Plastic		
Chemicals		
Food	COST	SOURDOMICS
Construction & demolition	EIB	Mauritius sugar project
Waste	Horizon 2020	SHAREBOX
	COST	Circular City Re.Solution
Others	COST	AEROGELS

Most of the identified programme fund many different projects that can be connected to the circular economy. However, there are not as many projects that involve cooperation between stakeholders from the European Union **and** those from other parts of the world. Therefore, the above list only includes some examples to which meaningful data could be researched.

More circular economy related project calls from the Horizon2020-Programme can be found in the document "Research& innovation projects relevant to the Circular Economy Strategy CALLS 2016-2018" by the European Union. [5]

2.2.7 Funding for circular economy-related research and innovation projects from each of the identified programmes/ programmes owners

There is no public data available for the exact amount of funding that the "Circular Economy Missions to Third Countries" of the European Union Commission supply to their projects.

The average COST Action support is 130.000 € per year for participation by typically 25 COST members, depending on budget availability. Exact number for the COST Actions focused on circular economy could not be researched. [2]

The Horizon2020-Program focusses on four different areas. One of these focus areas is called “Connecting economic and environmental gains – the Circular Economy², it has a total budget of 964 million €. [6]

The European Investment Bank EIB has been lending 2.116 million € in the period 2013 – 2017 to projects connected to circular economy. However, this number refers to all circular economy projects, not only those that include a cooperation of stakeholder from the European Union and from other parts of the world. [7]

2.2.8 CONCLUSION - LEVEL OF ALIGNMENT WITH CE

In conclusion to the gathered information one can see that there is already some cooperation between programmes owners in the EU and in other parts of the world in the field of Circular Economy that is being enforced by the introduced programmes and initiatives. Nevertheless, there are still improvements to be made.

3 INTERNATIONAL ORGANISATIONS

3.1 G7/G20

Founded in 1975, the Group of Seven (**G7**) is a group of industrialised countries consisting of Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States. The G7 countries represent about half of the global gross domestic product (GDP) based on nominal values. The European Union is also represented at the G7 summit.

The Group of Twenty (**G20**) is an international forum for the governments and central bank governors from 19 countries and the European Union (EU). Founded in 1999 with the aim to discuss policy promoting international financial stability, the G20 has expanded its agenda since 2008. G20 addresses issues that go beyond the responsibilities of any one organization. Together, the G20 economies account for around 90% of the gross world product (GWP), 80% of world trade and two-thirds of the world population.

During the German G7 presidency in 2015 it became possible for the first one to place resource efficiency on the agenda as a focus of discussions [1].

The German government placed resource efficiency on the G20 agenda for the first time in 2017 [2].

3.1.1 Objectives

According to the German Government, the objectives of promoting resource efficiency at G7 were following: “Natural resources, especially raw materials, are essential factors of production and fundamental for value creation. Resource efficiency is therefore a key issue for competitive businesses and securing jobs in the future. The careful, efficient and sustainable use of natural resources can limit environmental impact, strengthen the competitiveness of the economy and create new jobs while securing long-term employment. Through the use of sustainably managed renewable resources we can conserve fossil resources.” [3]

The reasons mentioned two years later by the G20 for promoting resource efficiency (in a very broad sense very similar to circular economy) were more detailed: “The aim is to use natural resources such as raw materials, water and energy more efficiently and soundly along their entire life-cycle in order to achieve the global Sustainable Development Goals (SDGs), combat poverty, take climate action

and protect the environment. The G20 countries will work together with experts, enterprises and the public for this purpose.” [2]

3.1.2 Main findings

On G7:

In October 2015 the **Alliance for Resource Efficiency** was launched in Berlin based on a decision taken by the heads of state and government of the G7 in June 2015. The opening meeting focused on an initial exchange on best practices in resource efficiency from the perspective of companies, employees and researchers as well as from the point of view of G7 partner countries. The discussion centred on the wide range of resource efficiency potential, which reduces environmental pollution and simultaneously strengthens sustainability, competitiveness and economic growth [1].

The G7 Alliance was launched as a voluntary forum for the sharing of knowledge and the establishment of information networks to meet this particular purpose. The heads of state and government came out in favour of ambitious steps towards increasing resource efficiency. Apart from the decision on the Alliance, they also gave a mandate to UNEP's International Resource Panel (IRP) to draw up a synthesis report. The purpose of this report is to highlight the most effective potential and list the most promising solutions. In their summit declaration the heads of state and government also asked the OECD to underpin the synthesis report by giving political guidance.

In October 2015 the Federal Environment Ministry and its UK counterpart organised a workshop on industrial symbiosis. Another conference under the auspices of the G7 Alliance on the substitution of non-renewable resources took place in Berlin in November 2015.

Both at the meeting of environment ministers in May 2016 and the G7 summit of Heads of State and Government in Ise-Shima in May 2016, representatives of the G7 countries reiterated the importance of resource efficiency for environmental protection, the climate, sustainable development and economic competitiveness.

The G7 environment ministers held their first meeting after a seven-year break in the city of Toyama in Western Japan, where they agreed on substantial steps to promote resource efficiency. They spoke out in favour of decoupling economic growth from natural resource utilisation. The Japanese G7 presidency intends to sharpen the focus on cooperation with emerging and developing countries, which account for the largest increases in resource consumption. This trend is bound to intensify, given the growing middle classes in emerging economies.

In the "Toyama Framework on Material Cycles", adopted as an annex to the meeting's communiqué, the environment ministers spell out several concrete actions for the years to come. The G7 member countries plan to increasingly integrate resource efficiency in their national policies and strategies, targeting the whole value chain. The countries also envision an expansion of the G7 Alliance on Resource Efficiency, transfer of technology and knowledge to developing and emerging countries and voluntary activities and initiatives within the economic sector and society. These activities should help make consumption more resource-efficient, contribute to the development of a resource-efficient circular economy and support the work required to improve international information resources.

Under G7 Italian presidency in 2017, the Ministries of Environment emphasized in their communiqué [4]: “There is strong evidence that Resource Efficiency, 3Rs, Circular Economy and Sustainable

Material Management can be a major driver to attain economic growth and employment, and can bring about environmental and social benefits together with long-term economic competitiveness and prosperity. This is fully recognized in the 2030 Agenda for Sustainable Development, where many Sustainable Development Goals (SDGs) and targets will only be attained if we improve resource efficiency globally.”

Further they adopted the “5-year Bologna Roadmap” which aims to advance common activities on resource efficiency.

At G7 meeting 2018 in Canada Environment Ministers “emphasized that improved resource efficiency policies minimize waste and maximize economic value while offering significant business opportunities and are a key part of the transitions to a sustainable, low carbon economy. This will require changing from use and dispose consumption to a more circular approach including behavior change. Many highlighted that taking a resource efficient approach has far reaching benefits such as reducing demands on natural resources, reducing greenhouse gas emissions, improving air quality and reducing negative impacts on biodiversity.” (...)

“that the transition to a circular economy is also important to address the challenge of marine litter. In this regard, acting along the lifecycle of plastics to address plastic waste was highlighted as a critical issue, beginning at the design stage.” (...)

“encouraged continued dialogue and sharing of best practices under the G7 and G20, in particular through the G7 Alliance on Resource Efficiency and the G20 Resource Efficiency Dialogue, including working with business on innovation. They also expressed support for the Alliance to establish an e-repository for the work and best practices.” [5]

An initiative focused on **sustainable waste management** was presented during the G7 Meeting 2019 [6] with support from Canada, Egypt, the European Union, France, Germany, Indonesia, Japan, Niger, Norway, the United Kingdom and the United States. The goal is to promote an inclusive transition and sustainable waste management while limiting impacts on vulnerable populations.

The French G7 Presidency and the European Commission have organized a workshop of the G7 Alliance on Resource Efficiency on “Tools making value chains more circular and resource efficient” in Paris on 20-21 March 2019 [7]. This workshop aimed to promote constructive exchanges between policymakers and companies to better exploit the economic opportunities and environmental benefits generated by more circular and resource efficient value chains.

On G20:

The G20 countries decided to establish a G20 Resource Efficiency Dialogue at the summit in Hamburg on 7-8 July 2017. The dialogue will make the efficient and sustainable use of natural resources a core element of the G20 talks [2].

The objectives and first subjects of the dialogue are fleshed out in an annex to the Hamburg G20 Leaders’ Declaration of 7-8 July 2017. For the time being, the G20 wants to focus on three topics:

- First, they will cooperate more closely on the implementation of the 2030 Agenda SDGs related to the use of natural resources. The International Resource Panel has indicated that 12 of the 17 SDGs depend on a more sustainable use of natural resources.

- Second, the G20 wants to improve the scientific basis of resource efficiency policy. To this end, different scenarios will be modelled showing how resource use could change under various conditions.
- Third, the G20 aims to enhance knowledge exchange of policy options and good practice examples that have been successful in improving resource efficiency, e.g. on the use of raw materials or water, on waste management or on the development of production processes and infrastructure.

Experts and representatives of international organisations, business and civil society may also be invited to the meetings of the G20 Resource Efficiency Dialogue to contribute with their knowledge and expertise. The kick-off event for the G20 Resource Efficiency Dialogue took place in Berlin on 27 November 2017.

The next “G20 Resource Efficiency Dialogue” was held on 27 August 2018 in Puerto Iguazú, Misiones, Argentina, to share knowledge and discuss options to promote a more efficient use of resources, as well as sustainable consumption and production patterns [8].

At the meeting in Japan in June 2019 the G20 Environment Ministers “recognized that improving resource efficiency through policies and approaches, such as circular economy, sustainable materials management, the 3Rs (reduce, reuse, recycle) and waste to value, supports our belief that economic growth and environmental protection can and should go hand-in-hand, contributing to the Sustainable Development Goals.” [9]

3.1.3 CONCLUSION – LEVEL OF ALIGNMENT WITH CE DEFINITION

Since 2015 for G7 and 2017 for G20, both on a proposal from the German Government, resource efficiency and more generally circular economy (since G7 meeting 2016 in Japan) are a focus of the annual exchanges of both groups of countries. As the EU is directly involved in G7/G20 the level of alignment of these institutions is very high.

3.2 OECD

3.2.1 Objectives

The Organisation for Economic Co-operation and Development (OECD) is an international organisation that works to build better policies for better lives. Their goal is to shape policies that foster prosperity, equality, opportunity and well-being for all [10]. The OECD RE-CIRCLE project provides policy guidance on resource efficiency and the transition to a circular economy and aims to identify and quantify the impact of policies to guide a range of stakeholders in OECD member countries and emerging market economies through quantitative and qualitative analysis [11].

3.2.2 Main findings

The RE-CIRCLE project is structured around two work packages:

1. The first work stream uses qualitative analysis on selected topics to guide policies to further the transition to the circular economy.
2. The second work stream uses global environment-economy modelling to project impacts of resource use and the effect of policy interventions.

The first work package on qualitative policy guidance encompasses several activities on priority areas. Plastics are given particular attention, as they are one of the major material waste streams where circularity is less developed and leakage into the environment is putting marine eco-systems

at risk. The planned work also covers specific economic policy instruments, the potential influence of digitalisation, assessments of particular material resources and food, the role and effects of circular business models on the environment, and resource efficiency in global value chains.

The qualitative analysis work stream aims to develop policy guidance in several areas that are key to circular economy transition:

- **Plastics:** OECD work in this area seeks to identify the policies that can reduce plastics waste and increase recycling of this ubiquitous material.
- **Digitalisation:** OECD work in this area seeks to better understand where digitalisation can be expected to provide significant opportunities or challenges for circular it and what some of the related policies interventions may be.
- **Policy instruments:** OECD works to develop further policy guidance on this and other market-based instruments.
- **Circular business models:** In this context, the OECD works to better understand the opportunities and challenges that this entails for enterprises and policy makers.

The second work package builds upon OECD's expertise in environment-economy modelling. The work investigates the interlinkages between materials use and economic activity, including the use of virgin and secondary materials in economic production. Modelling tools are used to examine plausible long-term trends in global materials use and assess the macroeconomic implications of policies to stimulate resource efficiency and the transition to a circular economy. These core assessments are complemented by more detailed analysis, including of the labour market and distributional consequences, resulting changes in international trade and links with climate change.

The modelling analysis work stream presents detailed projections of sectoral economic activity and resource use for the world and specific major economies. The RE-CIRCLE modelling analysis is comprised of two components:

1. An Outlook covering the economic drivers of materials use to 2060 is used to make baseline projections of materials use in the absence of new dedicated policies.
2. The economic, resource and environmental impacts of a broad set of policies that aim at improving resource efficiency and enable the transition to a circular economy are studied.

The work in this activity develops OECD modelling tools by linking physical resource flows (fossil fuels, materials) to specific economic activities and - to the extent possible - integrating essential elements of a circular economy, such as recycling of waste products as secondary inputs into production, and the use of secondary inputs as substitute for primary resource use.

Multi-sectoral Computable General Equilibrium (CGE) models such as the OECD's ENV-Linkages are an appropriate tool for quantifying the macroeconomic consequences of the transformation of the economy needed to improve resource efficiency and transition to a circular economy.

Macroeconomic analysis can complement existing sectoral assessments of resource efficiency which can have more detail on specific resource requirements but lack linkages to the rest of the economy. The ENV-Linkages model encompasses all major economies in the world, as well as several regional groups, allowing for a global analysis. This global dimension ensures that all quantitative analyses are directly relevant for both OECD countries and key emerging economies, including China, India, Indonesia, South-Africa and Brazil.

The multi-sectoral nature of the model also allows for detailed insights into the consequences of policy reform on various sectors and provides key indicators of the consequences for main policy objectives, including employment consequences. This provides countries with internally consistent and globally connected scenarios of economies around the globe as they evolve over time [12].

3.2.3 CONCLUSION – LEVEL OF ALIGNMENT WITH CE DEFINITION

The OECD's RE-CIRCLE project aims to identify and quantify the impacts of policies that could support a more circular economy. There are two main streams of work. The first uses global environment-economy modelling to project the impacts of continued resource use, and the effect of policy interventions. The second applies qualitative analysis to a set of selected topics in order to guide policies to further the transition to the circular economy [13].

3.3 UNITED NATIONS: UN ENVIRONMENT (UNEP)

3.3.1 OBJECTIVES

The United Nations and its Environment Program pay important attention to the Circular Economy especially in the areas of Remanufacturing, Refurbishment, Repair and Direct Reuse. They call it “The Manufacturing Revolution”. Production and consumption processes should be seen as low carbon drivers and not as deplorable of resources. Innovation is considered as the motor of change especially by gaining to achieve the SDGs (SDG 12).

3.3.2 MAIN FINDINGS

UN Environment Program [14] is the leading global voice on the environment. It provides leadership and encourages partnership in caring for the environment by inspiring, informing, and enabling nations and people to improve their quality of life without compromising that of future generations. UN Environment works with governments, the private sector, and the civil society and with other UN entities and international organizations across the world. Its main functions are:

- climate change including the Territorial Approach to Climate Change (TACC)
- Disasters and Conflicts UNEP has endeavoured to lighten the influence of emergencies or natural disasters on human health and to prepare for future disasters. It contributes to the reduction of the origin of disasters by controlling the balance of ecosystems and actively supports Sendai Framework for Disaster Risk Reduction which aims to reduce the risk of disasters (DRR).
- ecosystem management
- environmental governance
- environment under review UNEP provides information and data on the global environment to stakeholders including governments, non-governmental organizations and the public for them to engage in realizing the Sustainable Development Goals.
- harmful substances
- resource efficiency represented by the International Resource Panel since 2007.

Among all these activities, the following are highlighted considering the relevance to the topic of this report:

Reports

The UNEP launch this report annually wise which connects the potential for resource efficiency through circular economy.

Report Redefining Value – The Manufacturing Revolution

The report “*Re-defining Value – The Manufacturing Revolution: Remanufacturing, Refurbishment, Repair and Direct Reuse in the Circular Economy*” from International Resources Panel presented in Yokohama, Japan deal with solutions to provide a breakthrough bringing environmental, social and economic benefits. “The Manufacturing Revolution” underlines the importance of this report especially focusing on the value-retentions processes which might be a benefit for governments, industry and customers [15].

It quantifies the current state and potential impacts of different processes within industrial economic systems. The report quantifies benefits by different product and processes such as material requirement, use of energy, waste, costs and job generation. It also highlights systemic barriers that might produce progress inhibition like market, technology, regulation and infrastructure and gives solutions on how to overcome these. Also, recommendations for companies are detailed in this report, explaining new ways of seeing the business system.

There are also recommendations for business leaders such as: adoption, evaluation, modification (product design priorities), utilization, contribution, providing, engagement, partnering, collaboration and coordination.

Building Circularity into Economies through Sustainable Procurement

Emphasizing the strong link between sustainability and public procurement the UNEP promotes this initiative to shift towards more sustainable patterns of consumption and production. The initiative Building Circularity into Economies through Sustainable Procurement [16] is based on the experience documented by partners and governments and pushes up a shared dialogue on how to best bring more circularity in the economies at global level. It is mainly addressed to public procurers and policy makers, as well as corporate buyers and business leaders. It underlines the role that sustainable procurement can play to accelerate circular economy.

It is divided in two pillars. The first one focusing on procuring more circular products, materials and services and the second one, promoting new business based on innovative and resource-efficient solutions.

Events

UNEP organizes regularly different events focusing on Circular Economy, to foster dialogue and identify key areas to foster sustainable development. On March 2019 the event “The contribution of sustainable finance to a circular economy” [17] was launched to identify way to contribute to sustainable consumption and production and a more efficient use of resources through the circular economy approach.

On June 2019 the first Great Lakes Circular Economy Forum took place in Canada. It focussed on bringing different stakeholders from the great lakes region, key companies and industries to exchange experiences and ideas on how to foster circular markets and economies in this region. Canada will be hosting the Circular Economy World Forum in 2020.

Also, capacity building programmes and events dealing with Circular Economy are organized by UNEP and UNITAR (United Nations Institute for Training and Research). The last one took place in Thailand and focused on strengthening online and offline circular economy and sustainable consumption and production. The Sustainable Consumption and Production (SCP) Academy, online course and tertiary curriculum materials aim to respond to the SCP challenges by improving the knowledge of young professionals from public sector, private sector and civil society organizations who can contribute to the design and implementation of innovative solutions for policies, business models, technologies, financing mechanisms and practices that promote sustainable consumption and production [18].

3.3.3 CONCLUSION – LEVEL OF ALIGNMENT WITH CE DEFINITION

Through different reports, events and trainings the UNEP is approaching the Circular Economy topics on a global skill. Main focus is placed into industry, design and remanufacturing. SDG12 sustainable production and consumption is the key challenge of UNEP.

3.4 UNITED NATIONS: PACE

3.4.1 OBJECTIVES

The United Nations in cooperation with the Ellen MacArthur Foundation has established a platform to accelerate the Circular Economy transition. This initiative runs as a public-private collaboration mechanism and project accelerator for the CE. PACE [19] will contribute to achieving SDG 12 on sustainable consumption and production by developing solutions for e-waste, plastic pollution and other SCP challenges.

3.4.2 MAIN FINDINGS

In 2017 the Platform for Accelerating the Circular Economy – PACE has been launched. It is represented by relevant key stakeholders like the CEO of Philips, UNEP, the International Resource Panel, Circle Economy and its hosted by the World Economic Forum. UN Environment and the Ellen MacArthur Foundation agreed to collaborate on a strong scientific basis for policy decisions, also at city level, to decouple economic development from environmental degradation. The platform aims to create systems change at speed and scale by enabling partners to:

- Develop blended financing models for circular economy projects, in developing and emerging economies.
- Help create and adjust enabling policy frameworks to address specific barriers to advancing the circular economy
- Bring the private and public sector into public-private collaborations to scale impact around circular economy initiatives

For this report following activities are highlighted as important:

Groups

PACE has created a global leadership group committed to leading a portfolio of projects and activities and work together to identify and solve specific barriers. It includes over 40 CEOs, Ministers and heads of international organisations. Between other some partners are: Cisco, Dell Technologies, European Investment Bank, Google, different embassies and the European Commission.

Projects

PACE catalyses projects and supports affiliated partner led projects to scale-up circular economy action on plastics, electronics, food & bio economy, business models and market transformation. Active projects on electronics and e-waste are already underway in China, Africa. Regarding the recovering of plastics, a project supporting markets is already running in ASEAN. Different strategies and road maps also including public procurement models are being launched in Europe [20]

Future planned activities on food and cities are under preparation. This has begun with a roadmap by conducting analysis and building the evidence base for shifting to a circular model for food. A consortium of 100+ organisations and businesses has been engaged to conduct the ground analysis with four Focus Cities.

Learning

Learning lessons and replication from projects will be transformed into new approaches, which might be shared among relevant stakeholders to drive scale. Different countries have already joined this initiative to be able to share their plans and views on the prerequisites to transition to a waste less economy and to learn from the experiences in other countries and businesses.

3.4.3 CONCLUSION - LEVEL OF ALIGNMENT WITH CE

Together with the WEF (World Economic Forum) and the Mac Arthur Foundation, the platform PACE has been initiated to accelerate the transition to the Circular Economy. Different countries and CEOs work together by launching projects, participating in consortiums and disseminating the activities and results.

3.5 UNITED NATIONS: UNIDO

3.5.1 OBJECTIVES

On April 2019 a total of 170 States are former members of UNIDO [21]. This specialized agency of the United Nations promotes industrial development for poverty reduction, inclusive globalization and environmental sustainability. The four strategic priorities from UNIDO are:

- Creating shared prosperity
- Advancing economic competitiveness
- Safeguarding the environment
- Strengthening knowledge and institutions

3.5.2 MAIN FINDINGS

The United Nations with its Department UNIDO Environment is increasingly focusing on Circular Economy and the industrial development opportunities. There have been launched different projects focusing on recycling, material flow in different regions of the world. Some of these projects and concepts still need to be improved to offer an added value to the programme. Together with ENV/SCD, UNIDO has launched several projects supporting this overall aim over the last years.

Each of the four strategic priorities mentioned above contains a number of individual programmes, which are implemented in a holistic manner to achieve effective outcomes and impacts through UNIDO's four enabling functions: 1. technical cooperation; 2. analytical and research functions and

policy advisory services; 3. normative functions and standards and quality-related activities; and 4. convening and partnerships for knowledge transfer, networking and industrial cooperation.

For this report following activities are highlighted as important:

Programmes

An important asset to Circular Economy is demonstrated through UNIDO's programmes. Which for example allow individual companies and industrial sector to have a sustainable way of making profit?

- **Circular Economy Opportunities** [22]: the programme was launched on 2018 in Uruguay. The UNIDO Regional Office in Montevideo aims to translate circular economy concepts into real business opportunities and provide concrete sustainable solutions to production challenges. It will also approach other southern regions of LA and the Caribbean.
- **Resource Efficiency**
- **Cleaner Production:** (RECP) means applying preventive environmental strategies to processes, products and services to increase efficiency as well as reduce risks to humans and the environment.
- **UNIDO-led SwitchMed:** offering resource efficient and environmentally friendly production solutions to companies by applying the Transfer of Environmentally Sound Technology (TEST) approach.

Projects

- **Circular Economy in UNIDO** [23]: The project aims to strategically position UNIDO as a preferred Technical Cooperation service provider on Circular Economy principles and practices in developing countries and economies in transition.
- **Industrial Eco-Parks** in Asia, Latin America, Africa.
- **E-Waste Strategy** [24]: This new strategy promotes the sound management of e-waste; secure handling of non-recyclable materials, and the highest possible recovery rate for valuable materials in Ethiopia.
- **Solid Waste Management training project:** project offers a hopeful model for addressing West Africa's most pressing environmental, economic and social problems.

Capacity Building

Training courses on circular economy are regularly offered by UNIDO under the Motto: "Policy Advice and Capacity Development". The aim is to bring policy makers from Ministries and stakeholders from industry, experts, providing them with a variety of policy instruments and showcasing to identify their role in the transition to a circular economy.

Events

UNIDO also organizes events approaching different topics in cooperation with different institutions and ministries. The conferences support the transition to a circular economy and aim to create a platform for exchange of best practices and build new partnerships among institutions and the private sector. On November 2018 the "Circular Economy-Developing Recycling Industries Meeting" [25] in Vienna hosted stakeholders representing the recycling industry, industry associations, think tanks and international organisations.

Groups

UNIDO promotes expert groups on “Circular Economy Development of Recycling Industries” where representatives from government and industry aim to chart a way forward for the promotion of circular economy in support of Sustainable Development Goals 9 and 12.

Advisor

UNIDO participates frequently as an advisor to important policy bodies and governments. On one of its publications called “Addressing the Challenging of Marine Plastic Litter using Circular Economy Methods” [26], UNIDO discusses how circular economy practices could be applied through the product design, production, use, end-of-first-life and disposal stages to short-lived and fast-moving plastic products and packaging. It recommends policy responses based on the experiences of G20 members.

Network

Since 1990 UNIDO in joint cooperation with UNEP are working together to support countries which are lacking on experience regarding resource efficiency strategies. Therefore, global networks have been initiated:

- **RECPnet:** specialized in providing Resource Efficient and Cleaner Production services to industry in developing and transition economies.

3.5.3 CONCLUSION - LEVEL OF ALIGNMENT WITH CE

UNIDO has promoted and initiated a series of programmes and projects encouraging governments from different countries of the world to adapt their policies to the circular economy principles. It also contributes to capacity building and training courses to allow industries and citizens to get attached to the concept of circular economy and adopt a way of responsibility. Its main goal is to support the SDGs.

3.6 WORLD RESOURCES FORUM ASSOCIATION

3.6.1 OBJECTIVES

The main objective of the World Resources Forum Association (WRFA) is to facilitate stakeholder dialogue and anchor knowledge exchange on sustainable resource, raw materials management, the circular economy and sustainable consumption and production amongst policymakers, NGOs, scientists, business leaders and the public.

3.6.2 MAIN FINDINGS

The World Resources Forum Association [27], located in Switzerland, is an independent non-profit international organization that serves as a platform to connect and foster knowledge exchange on sustainable management and usage of resources worldwide. To achieve its objective, WRFA performs the following activities:

- Organisation of high-level international conferences on natural resources, i.e. the World Resources Forum (WRF) Conference
- Leading and contributing to projects in the field of resource and raw materials management,
- Organisation of capacity-building workshops, education and training regarding natural resources for and with stakeholders from emerging and developing countries

- Dissemination and communication of the conferences' outcome
- Dissemination of relevant research findings and scientific discussions
- Development of online training on resource management

Among all these activities, the following are highlighted considering the relevance to the topic of this report:

World Resources Forum Conference

World Resources Forum (WRF) conference is the annual flagship event of the WRFA, which allows the sharing of knowledge and creates debate amongst all stakeholders involved in the resource management discourse. The conference is widely recognized for its global and multidisciplinary character, usually gathering between 400-1000 participants including policymakers, business leaders, NGOs, researchers and the broader public who are coming from all over the world. The WRF conference is a mix of plenary session, workshops, scientific sessions, exhibitions, press conference and social programmes. Every two years the conference is held out of Switzerland with a regional focus on issues pertaining to specific geographic areas (e.g. previous events in China, Australia, Latin America and Caribbean and Belgium [28]). Dissemination and communication of the conferences' results in form of reports [29] are among the main activities of the organization.

The upcoming WRF will be held in Geneva, October 23-24, 2019, with the leading theme "Anchoring Natural Resources and Raw Materials Management for Achieving Sustainable Consumption and Production"[30].

The entire WRF 2015 conference in Davos, Switzerland, was devoted to Circular Economy with a focus on "Boosting Resource Productivity by Adopting the Circular Economy". Attendees at this event formulated global, national, regional and local policy recommendations and proposed strategies for further action and research. These outcomes are publicly available in meeting reports.

Leading and contribution to projects

Whereas the WRF conferences are best known and visible to a wide audience, the core of the multi-stakeholder dialogue vision is fulfilled by leading and contributing to projects in the field of resource and raw material governance and resource (efficiency) management. Among several projects, following is a list of selected projects that are more related to the topic of the current report (i.e. circular economy):

Sustainable Recycling Industries (SRI) programme

The Sustainable Recycling Industries [31] (SRI) programme contributes to favourable framework conditions that enable the development of a sustainable recycling industry for e-waste and related waste streams in developing countries. The overall objective of the programme is to build capacity for sustainable recycling in developing countries. The programme is funded by the Swiss State Secretariat of Economic Affairs (SECO) and is implemented by the Swiss Federal Institute for Materials Science & Technology (Empa) and WRFA. In the frame of this programme and under the International Organization for Standardization (ISO), an International Workshop Agreement (IWA) for the Sustainable Management of Secondary Metals (Guidance Principles) has been developed [32].

The first phase of this programme concluded in 2018 and the second phase will start in mid-2019. This phase will be focusing on governance and technology aspects that allow for an optimal recovery of secondary raw materials and the safe management of hazardous substances. In all its activities, SRI

strives for inclusive approaches, aiming at beneficial economic conditions for both the private industry and the informal sector. SRI leverages the concept of a circular economy and contributes to actions on climate change mitigation through a reintegration of secondary raw materials into industrial processes. In this phase, WRFA will stay in its position as the overall programme coordinator and will oversee activities to implement sustainable e-waste management solutions in partner countries and will be leading the overarching knowledge component.

E-Waste in Ghana – Recycling Chains, Business Models and Capacity Development

WRFA is currently part of an international consortium to offer consultancy services for GIZ's (Deutsche Gesellschaft für Internationale Zusammenarbeit [33]) technical cooperation project in Ghana, specifically regarding "Recycling chains, business models and capacity development". With the goal of improving the conditions towards a sustainable e-waste management in Ghana, WRFA and its consortium partners will focus, among others, on the following clusters of activities:

- Provide training courses for informal sector e-waste recyclers
- Develop business models to improve operations towards more sustainable e-waste recycling practices, including the optimization of current practices and the integration of the informal sector
- Develop business models for alternative income opportunities for individuals involved in the most harmful processes
- Analyse treatment steps and adequate technology options to achieve a sustainable e-waste value chain for all relevant e-waste categories, as well as to provide guidance on how to connect the Ghanaian value chain on regional and international levels to maximise the local value chain and the necessary investments.

CICERONE Project

WRFA is one of the partners of the CICERONE project and is mainly involved in stakeholder engagement, international benchmark and development of a MOOC for programme owners. The first CICERONE stakeholder consultation workshop was organized back to back with the WRF 2019 in Antwerp. The session focused on identifying barriers, opportunities and priorities for circular economy programming and financing.

WRFA has been involved (as the main coordinator) to other Horizon 2020 project such as FORAM [34] project (Towards a World Forum on Raw Materials, 2016-2018) and the CEWASTE [35] project (Voluntary certification scheme for waste treatment, 2018-2020).

Capacity building workshops

WRFA runs capacity building workshops for SMEs, policy makers and the informal sector, sharing expertise among others on eco-efficiency, recycling of e-waste and health and safety standards for recycling workers, sustainable consumption and production, life cycle analysis and product design. Further workshops on circular economy and decoupling economic growth from resource strain are run by WRFA during major sustainability conferences worldwide, including UNECA African Developmental Forum, COP11 Meeting on Biodiversity, EU Green Week and ICT for Sustainability Conferences.

Development of online training on resource management

WRFA has developed a Massive Open Online Course (MOOC) on "Resource Revolution Trainer – Coupling sustainability with excellence" [36]. The aim of this online course is to promote use of the

scientific findings of the UN International Resource Panel (IRP) among the business community. In doing this, the online trainer also features related business publications and encourages business action towards products, services and systems for a more resource efficient and resilient future.

Moreover, WRFA has been involved in development of the MOOC on “The E-waste Challenge”, acting towards circular economy [37]. This MOOC was the result of a partnership between UNEP, Basel Convention, KU Leuven and EIT Raw Materials.

3.6.3 CONCLUSION - LEVEL OF ALIGNMENT WITH CE

The main focus areas of the WRFA are the sustainable management of resources and raw materials, circular economy, and sustainable consumption and production. With its close cooperation with relevant organizations such as the MacArthur Foundation, Sitra (World Circular Economy Forum), WBCSD (World Business Council for Sustainable Development) and UNEP, WRFA has been instrumental to put Circular Economy on the map and is actively involved in facilitating the dialogue and anchoring knowledge exchange on related topics.

3.7 OBJECTIVES FROM INTERNATIONAL ORGANISATIONS

The objectives of the analysed international organisations when supporting circular economy are quite different (see Table 6). All of them wish to establish a circular society and support dialogue and education. Only G7/G20 address all objectives identified in the project. Three objectives are mentioned for half of the organisations: reduce resources consumption / sustainable production, support economic growth and protect the environment. Improve waste management is only considered as a main objective by G7/G20 and PACE. Climate protection is only mentioned once.

Table 6: Objectives in international organisations

Objectives	Improve waste management	Reduce resources consumption / sustainable production	Climate protection	Support economic growth	Protect the environment	Establish a Circular society / Education / Dialogue
G7/G20	X	X	X	X	X	X
OECD				X		X
UN Environment		X			X	X
PACE	X	X				X
UNIDO				X	X	X
WRFA						X

3.8 MAIN FINDINGS FOR INTERNATIONAL ORGANISATIONS

Circular economy is a central topic for all organisations considered. The objectives differ but there is an active cooperation between these organisations in order to achieve these. The international organisations play a fundamental role in the dialogue between the countries and stakeholders, supporting education and knowledge transfer with studies, reports, events, policy briefs and other tools. Even if these organisations do not fund R&I activities, they have a high influence on policy makers and therefore on programming concrete measures incl. funding programmes.

3.9 CONCLUSION FOR INTERNATIONAL ORGANISATIONS

Through close cooperation between the European Union and all international organisations considered the level of alignment with CE definition is very high. Another important point is the broad involvement of policy makers, industry, academia, civil society and other stakeholders from local to global level.

4 EXAMPLES OF INDUSTRIAL COUNTRIES

Five industrial countries have been analyzed: Australia, Japan, South Korea, Taiwan and the USA.

4.1 AUSTRALIA

4.1.1 OBJECTIVES

Australia decided to invest in circular economy due to mainly waste management issues. As reported by Parliament of Victoria [1], there has been considerable concerns in Australia in recent years about recycling efforts, and what happens to products once they are recycled, caused mainly by China's decision to ban the import of foreign waste from January 2018 [2]. In fact, Australia exports recyclable material to over 100 countries and a considerable amount of them went to China. Therefore, the decision made by China to ban the import of foreign waste has a direct impact on recycling and waste management practices in Australia.

Transition to circular economy was selected a possible strategy to overcome this issue, seeking “to close industrial loops and to turn outputs from one manufacturer into inputs for another and, in doing so, reduce the consumption of virgin materials and the generation of waste”.

For this reason, in June 2018, the Senate Environment and Communications References Committee published its report on the waste and recycling industry in Australia, where the first recommendation made by the Committee was that the Australian Government should establish a circular economy.

4.1.2 MAIN FINDINGS

Australia is a Federal industrial country with a GDP of 0.61 trillion € as of 2017 [3], the 13th-largest national economy by nominal GDP. The Country has the eighth-highest total estimated value of natural resources, valued at 17.5 trillion € in 2016, with largest gold reserves in the world, and it supplies over 14% of the world's gold demand and 46% of the world's uranium demand. Australia is top producer of opal and aluminium.

Circular economy is a recognized as an economic model in the country and different policies and strategies have been defined, including dedicated programmes. Materials resources and energy are integrated in a circular economy Australian vision. However, even if the circular economy concept is well known since many years (e.g. a network of professionals helping to drive the awareness and adoption of Circular Economy principles in Australia was created in the country in 2010 [4], indicating a growing interest of Australia in circular economy), the approach was adopted quite recently at institutional level, due to specific issues overcome in the country related to waste management, as detailed in Objectives section. Due to its Federal government, policies and dedicated programmes were issued at regional level as well as at national level.

Government of South Australia reports [5]: “Circular Economy is an alternative to the wasteful traditional ‘linear’ economy based on ‘take, make, use and dispose’. It's a self-sustaining system

driven by renewable energy with an imperative to keep material resources in use, or circulating for as long as possible. It extracts the maximum value from these resources while in use, then recovers and regenerates products and materials. A truly Circular Economy is driven by renewable flows, rather than finite stocks. It depends on renewable energy sources, including wind, solar and bioenergy, rather than coal and other fossil fuels and materials from renewable sources”.

South Australia has promoted the Global Leadership Program on the Circular Economy, an initiative of Green Industries SA and the United Nations Centre for Regional Development, aiming to “give business and government leaders the practical skills to make a difference in the circular economy”. The programme includes different themes, indicating an integrated approach, as detailed here below:

Circular economy policy and practice

- Climate change
- Energy efficiency
- Renewable energy – battery storage, smart grid
- Waste management, recycling and resource efficiency
- Economic/market instruments

Community and society

- Community education, engagement and partnerships
- Behavioural change programmes
- Smart cities, resource efficient and resilient

Communities

- Living cities - sustainable landscape architecture

Industry

- Sustainable procurement
- Innovation incubators and technology
- Industrial symbiosis - circular industrial estates
- Resource efficiency in industry

Water management

- Wastewater reuse
- Water sensitive urban design
- Storm water reuse, wetlands and aquifer storage

Finally, the New South Wales Government is investing about € 920.000 to establish a Circular Economy Innovation Network [6], coherent with New South Wales Circular Economy Policy [7].

Australia is a developed country with a level of Circular Economy concept comparable with Europe, as detailed in appropriate section. However, as explained, the approach is quite new in the country, due to waste issue overcome recently (2018). The most important national/regional programme really dedicated to Circular Economy has recently started, then, and concrete and measurable findings still not occur.

However, some conclusions could be drafted:

- 1) Waste management is the main focus, but an integrated approach is visible (e.g. Circular economy network, integration material resources – energy)
- 2) Education and training play a relevant role

3) Directly involvement of regional/national administration clearly occur

4.1.3 CONCLUSION - Level of alignment with CE

Two main factors for level assignment were considered:

- 1) Overall involvement of local government in implementing CE-related actions, including programmes cofounding
- 2) Results status of CE-related programmes

Australia refers to European Circular Economy concept and definition, even if the approach at institutional level is quite new in the country, as detailed above. The level can be assessed as 2.

4.2 JAPAN

4.2.1 OBJECTIVES

The objectives of CE related research and innovation funding programmes in Japan are to establish a "Circular Society". As a goal, circular economy is only a part of it, focusing more on the establishment of a circular civilized society in Japan, so as to leave a better living environment for next generations.

4.2.2 MAIN FINDINGS

Nowadays, the circular economy-related research and innovation in Japan is based on and greatly promoted by Japanese national strategy- Fundamental Plan for Establishing a Sound Material-Cycle Society.

The **Japanese strategy for the circular economy** can be summarised as follow:

In 2003, the 1st version of the Fundamental Plan for Establishing a Sound Material-Cycle Society launched. Japanese government set the overall strategy of Japan's Circular society as a reduction, recycling, and reusing in total material input, resource extraction, waste generation and energy consumption. This plan strived to reduce natural resource consumption and environmental load [8].

In 2008, the 2nd version of the plan was carried out. This plan extended its scope of circular social promotion to the international scale, aiming at becoming the centre of circular society in East Asia. The secondary resources which other countries cannot handle can be regenerated by Japan with its advanced technology, further reducing the global environmental load and enriching domestic material resources. Meanwhile, international industrial and academic institutes are encouraged to exchange information and study in Japan [9].

In 2013, the 3rd version of the plan was implemented. The roles and key tasks of each stakeholder are defined more clearly. In particular, the industrial sector is subdivided into manufacturing, retailing, waste disposal, recycling, financial institutions and investors. Owing to the experiences of 2011 Tohoku Earthquake and Tsunami, the regulatory supplement of the disaster waste disposal was enhanced [10].

In 2018, the 4th Fundamental Plan for Establishing a Sound Material-Cycle Society was approved by the Cabinet on June 19th, 2018, indicating measures to be implemented in a strategic manner. The Plan is formulated based on the Basic Act on Establishing a Sound Material-Cycle and sets a mid-to long-term direction for the establishment of a sound material-cycle society in Japan [11].

- Resource Circulation throughout the entire lifecycle: Through the 4th Industrial Revolution, conduct resource circulation through the entire lifecycle by providing the necessary products and services to persons in need, when necessary, and in the necessary amounts.
- Strengthening upstream actions
- Expanded use of recycled materials, design for the environment, 3D modeling, etc.
- Promotion and evaluation of business related to 2Rs, incl. sharing

Priority areas:

Plastics: Establishment of a "Plastic strategy" and promotion of accompanying measures. The steps for plastic resource circulation are:

- Reduce use of disposable containers/packaging and plastics for environmental impact reduction
- Collect and recycle used and unused plastics thoroughly and effectively
- Enhance practicability of bio plastics and promote use of alternatives for fossil fuel-derived plastics.

Biomass: National campaign to reduce food waste, measures against inappropriate recycling of food waste, and efforts toward food recycling

Metals: Promoting the collection and recycling of small home appliances, along with the Tokyo 2020 Metal Project

Stone/ construction materials: Reducing construction and demolition waste by strengthening buildings and prolonging their lifespan

Recently spread products and materials

- Mandatory recycling system for solar power generation facilities
- Diaper recycling

Achievements until 2015: [12] Resource productivity improved by 58% and final disposal amount reduced by 74% due to policy advancement over 15 years since 2000

Targets and Indicators for Progress Monitoring:

Resource productivity: 3.132 €/ton in 2015, compared with 2.060 €/ton in 2000
Final disposal amount: 14 million ton in 2015, compared with 60 million ton in 2000

Kitakyushu Eco-Town Project [13]

In 1901 the state-owned Yahata Steel Works went into production, and then the Industrial Zone of Kitakyushu started to turn a new page in the modernization of Japanese industry, making it one of Japan's four major industrial zones and contributing a lot to Japan's post-war economy.

However, with highly developed industrial development for pursuing economic merit, serious industrial pollution is unavoidable. With an eye to taking actions to create a recycling society and contribute to environmental conservation and industrial promotion, in 1997, Kitakyushu Eco-Town Project was approved by the Ministry of Economy, Trade and Environment of Japan and the Ministry of Environment to be the first granted eco-industrial park for developing technology, human resources and know-how with the aim of "be utilized as raw material for other industries all wastes, to zero emission", and promote the construction of recycling-based societies.

- The project consists of 434 companies in 20 square kilometers.
- In the first six years of the project, over 6400 jobs were created and 1.2 billion € was invested.

The total investment amount is 638 million € (until March 2017) [14]

Investment amount:

- Industries: 470 million €
- Government: 109 million €
- Cities: 58 million €

There are three characteristics in this project:

1. Education and Fundamental Research

- In addition to participating in the research and commercialization, industrialization research and experiments of various environmental protection technologies, many universities are also actively engaged in higher education, personnel training and fundamental research.

- Encourage visits to convince local communities of practical results

2. Technology and Empirical Research

This area includes university research institutions and enterprise experimental demonstration facilities, and it is also the largest research complex in Japan. Because of long distance from the residential area, with fewer limits, the experiment is mainly the actual test of the application-oriented research

3. Environmental technology industrialization

- Integrated environmental protection joint enterprise area: including recycling plants focusing on plastic bottles, home appliances, office equipment, fluorescent lamps, automobiles, medical equipment, construction mixed waste recycling. Several large-scale resource recycling companies in the region will be gathered together to take advantage of the management of the input and output of the waste material, common pipelines, roads and other infrastructure, common custody, warehousing, exchange and trafficking, to achieve massive recycling treatment and processing costs reduction.

- Hibiki Reuse factory area: Two areas are divided: 1) research experimental area and 2) local vehicle waste recycling research test area, including recycling plants focusing on edible oil, wastepaper, organic solvents, waste vehicles, bottles and other items. These areas are more inclined to encourage small and medium-sized enterprises to develop innovation.

- Other regions: plants focusing on the reuse of wind power, waste wood (or waste plastic), PACHINKO machine reuse, cartridge reuse, beverage can reuse plants.

Conclusion

The park successfully combined with academic research institutes, various types of recycling plants and re-use plants to achieve the industrialization of environmental protection. With the cooperation among the public, academic institutions, enterprises and governments, everyone works together to overcome environmental hazards, successfully turn the crisis of economic development into an opportunity for development and solve the global concerns about environmental protection.

Main funding for circular economy-related research and innovation in Japan

The Fundamental Plan for Establishing a Sound Material-Cycle Society is literally a kind of Economy-wide Material Flow Analysis, EW-MFA. In order to specifically examine the effectiveness of the material flow, the quantitative targets and trend observation indicator are set up. The material flow target in Japan can be divided into three aspects: input, cycling and output. Besides, there are also three indicators-resource productivity, cyclical use rate and final disposal amount. The overall material flow target of 2020 in Japan is 3811 euro/ton, cyclical use rate 17% and the final disposal amount 17 million tons. The commercial market scale will be double in 2020 compared with the one in 2000, equalling to 520 billion euro).

Main players in the economy-related research and innovation in Japan [15]

a) The state

While promoting partnership with relevant actors, the state will lead nationwide efforts toward establishing a sound material-cycle society by introducing and reviewing regulatory, economic, and other measures appropriately.

b) Local governments

Local governments, which are expected to play an important role in ensuring proper cyclical use and disposal of waste and coordinating among participating actors, will play the core role in establishing a sound material-cycle society in their respective regions.

c) Citizens

Citizens are expected to behave in a manner based on the recognition that they are a generator of waste, etc. and responsible for the environmental loads produced by themselves and that they are a key player to work on changing their lifestyles to ones with less environmental impact.

d) NGO and NPO

NPOs and NGOs conduct activities instrumental in creating a sound material-cycle society and engaging in community business or other initiatives in their regions. Evaluating each actor's economic and social activities and enhancing collaboration to make sure if they move toward a sound material-cycle society is the main task.

e) Academic and research institutions

Academic and research institutions are expected to enhance their advanced and specialized knowledge, provide objective and reliable information in an easy-to-understand manner, and encourage and support decision-making on policies for the establishment of a sound material-cycle society and each actor's concrete actions.

f) Business operators

Business operators should place social responsibilities as their top priority, which is vital to sustainable development.

g) Waste disposal and recycling industry

In order to conserve the surrounding living environment and improve the sanitary condition, waste disposal businesses should treat waste as precious valuable resources and strive to extract useful resources from waste for cyclical use.

h) Financial institutions and investors

Financial institutions and investors are expected to be financing companies.

4.2.3 CONCLUSION - Level of alignment with CE

In 2000, Japan government started to set up “Fundamental Plan for Establishing a Sound Material-Cycle Society”, published the first version of it in 2003. This policy planned to promote the establishment of a circular society in a comprehensive manner from the perspective of the State, non-governmental organizations (NGOs) and non-profit organizations (NPO), industry and local public bodies. This fundamental plan for the formation and advancement of circular societies has been published every five years since 2003. The 4th version plan has been published in 2018. Each year, the policy will be reviewed and issued a review report.

The level can be assessed as 3.

4.3 SOUTH KOREA

4.3.1 OBJECTIVES

South Korea government has positively taken substantial actions to transit into a circular economy although Korea has been successful in the linear economy for nearly a decade. For decades, in order to overcome the environmental resource constraints and the industry-based industrial model has led to a surge in greenhouse gas emissions, making it a source of energy consumption and greenhouse gases (GHG) primary emitting countries [16].

South Korea's economy is highly dependent on resource-intensive industries such as steel, petrochemicals and cement, and is considering improving the future percentage of GDP in service industries. In order to solve massive electronic engineering waste treatment and to reduce the potential environmental influence of waste electronic engineering products, the ultimate goal of recycling technology programme (RTP) is to create the technical facilitator of circular economy in South Korea, and to develop the rare precious metal recycling technology of waste electronic engineering products.

Recycling technology in Korea is considered a typical green technology. Key Green Technology Development and Commercialization Strategies, launched in 2009, consists of five core technologies, such as climate change, energy development technology, efficiency enhancement technology, pipe end processing technology and virtual reality research.

4.3.2 MAIN FINDINGS

The circular economy-related research and innovation in South Korea is focused on five programmes:

TMS (target management system): The goal of TMS, which also sets national medium-term target, is to reduce greenhouse gas emissions aiming at the emission-intensive industries. TMS sets up the reduction targets for companies in several fields to meet the requirement of the reduction goals. The fields include power generation, manufacturing, construction, waste management and transport. Penalty will be paid if the companies fail to reach the goal.

REP (resource efficiency programme): REP attempts to convert substances into energy equivalent, which can reduce GHG emission by using fewer resources. That is, REP can reduce energy intensity and thus, further, reduce carbon intensity.

ERP (energy recovery programme): ERP is associated with the intensity of carbon emissions from energy, which can reduce carbon intensity if energy can be retrieved from waste.

RTP (recycling technology programme): RTP focuses on advanced recycling technology development. RTP can facilitate the transformation of the circular economy through the reconciliation of carbon emission increase and energy GHG emission decrease. The initial goal of RTP is to reduce the GDP proportion in resource-intensive industries.

ETS (emission trading system): ETS can be used as a market pricing mechanism that meets the medium-term reduction target and can be extended to the energy GHG emission related certificate trading platform.

This well-designed policy mix, which would be promoted in a cost –effective way, would facilitate the shift to a circular economy.

South Korean strategy for the circular economy

South Korea's economy is highly dependent on resource-intensive industries such as steel, petrochemicals and cement, and is considering improving the future percentage of GDP in service industries. In order to solve massive electronic engineering waste treatment and to reduce the potential environmental influence of waste electronic engineering products, the ultimate goal of RTP is to create the technical facilitator of circular economy in South Korea, and to develop the rare precious metal recycling technology of waste electronic engineering products.

Recycling technology in Korea is considered a typical green technology. Key Green Technology Development and Commercialization Strategies, launched in 2009, consists of five core technologies, such as climate change, energy development technology, efficiency enhancement technology, pipe end processing technology and virtual reality research.

Recent measures to promote recycling in South Korea include recovery target rates, extension of producer responsibility lists, distribution of distributors and producer responsibilities, and strengthening of local recycling systems. With the development of advanced waste recycling technology, the Government encourages producers to adopt environmentally sustainable technologies by setting up relevant regulation in advance.

Main funding for circular economy-related research and innovation in South Korea

Since 2010, South Korea government started to grant Green Certificates to qualified industries, projects and technologies. Green Firm is granted for the company whose certified green technology sales accounts for more than 30% of its total sales. Green enterprises, projects and technologies are financed by green financial products, and the share of green financial investment accounts for more than 60% green enterprises and projects. Green financial investment products include green bonds, deposits and investment funds. Green private equity funds are also open.

Green financial products also offer tax concessions, and dividends and interest on green financial products are eligible for a tax-free incentive. However, at present, recycling technology is still struggling to attract private investment, so government involvement is imperative. There is also a need to strengthen mechanisms for the transformation or withdrawal of resource-intensive industries.

National Eco-Industrial Park Master Plan (EIP master plan)

The Korean National Cleaner Production Center (KNPC) launched the National Eco-Industrial Park (EIP) programme in 2003. The programme is currently run by the Korea Industrial Complex

Corporation (KICOX). Since 2005 the implementation of a three-phase phase plan has been activated with different targets and funding at each stage. Eight demonstration areas have been supported, one of which is the Ulsan Eco-Industrial Park. The plan is scheduled to be finalized in 2019.

Phase 1 (Nov 2005- May 2010)

The investment of the first phase is 15,2 million € for establishing five demonstration zones.

The main objectives of this phase are to establish a co-ordinating team to explore the feasibility of transforming a traditional industrial zone into an eco-industrial park, to collect data on raw materials, products, by-products, waste inputs and outputs, and to integrate the resources of each plant by elaborating the exchange of energy resources in the traditional industrial zones. By doing so, it will lead traditional industrial areas to be more efficient and sustainable eco-industrial parks.

Phase 2 (Jun 2010- Dec 2014)

The second phase of the investment is the most vital of the three phases with the funding up to 61 million € for building three more demonstration sites, which was accumulated to be eight in total. This phase is aimed at eight demonstration sites and 30 other relevant industrial zones, enhancing more in-depth detailed data collection and the introduction and dissemination of ecological park-related knowledge and experience, to promote industrial symbiosis network. In particular, this phase also introduces competition mechanisms, with different incentive funding based on the industry symbiotic performance ratings generated by the demonstration sites.

Phase 3 (Jan 2015- Dec 2019)

The third phase of the investment funds is 6,6 Million €. The purpose of reviewing cases of success and failures in phases I and II include performing overall performance analysis in specific situations, revising implementation strategies, and planning to apply successful models to national industrial symbiosis systems. Ultimately, establish a national network of eco-industrial parks. As of 2015, 388 projects were funded by KICOX. The companies adopting Industrial Symbiosis (IS) facilities have benefited 1,5 million € by saving resources or selling waste and by-products through IS systems.

Take the Ulsan Eco-Industrial Park for example, the first phase will establish an eco-industrial park centre and team and select a key implementation plan for data collection. The second stage identifies industrial symbiosis opportunities from two paths, "top down" and "bottom up" research and develops viable business models. Finally, the third stage establishes formal cooperative relations, signs contracts, builds infrastructure and institutions, and continuously optimizes industrial symbiosis programmes [16] (see Figure 1).

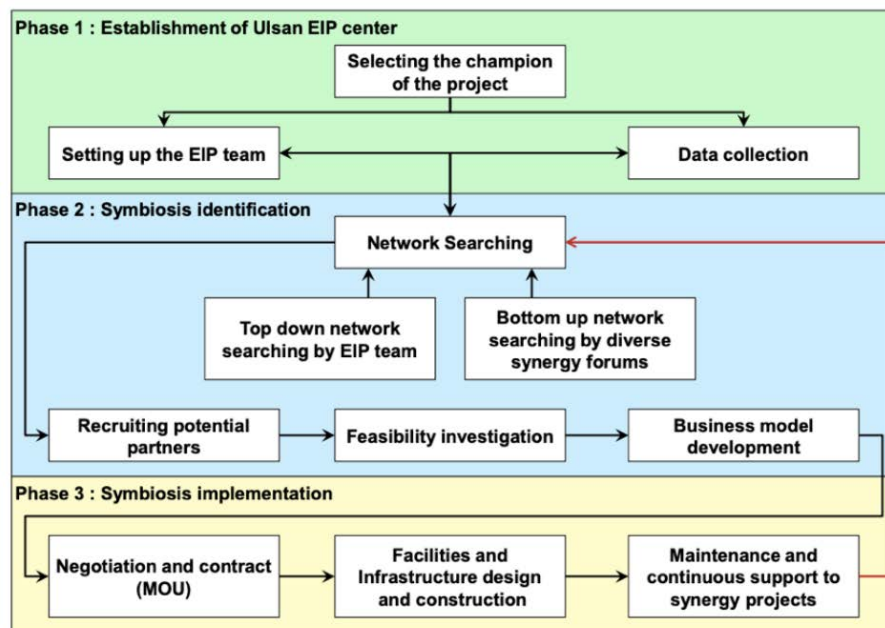


Figure 1: The three phases of Ulsan Eco-Industrial Park [17]

Ulsan Mipo and Onsan is part of South Korea’s Eco-Industrial Park Initiative, which seeks to transform traditional industrial complexes into sustainable EIPs. Firms in Ulsan Mipo and Onsan have invested some 464 million € in energy efficiency, industrial symbiosis, waste management, and other eco-friendly improvements. To date, the investment has yielded 494 million € in savings, while firms in the EIP generated 81,6 billion € in revenues [18].

Spurred by government investment of 13,2 million €, companies in the park reduced their CO₂ emissions in 2015–2016 by 665.712 tons, reused 79.357 tons of water, and saved 279.761 tons of oil equivalent in energy use. These changes have enhanced relations with local communities by improving the negative image of industrial complexes as polluters [17].

Main players in the economy-related research and innovation in South Korea

a) The state

The recycling technology has difficulty attracting private investment, so the government should set up beneficial regulation and provide incentive funding.

b) Manufacturers/ Consumers

Manufacturers should be provided with incentives to improve their products' efficiency. Consumers, on the other hand, should be provided with incentives to purchase energy-efficient products.

c) Citizens

Citizens are expected to behave in a manner based on the recognition that they are a generator of waste, etc. and responsible for the environmental loads produced by themselves and that they are a key player to work on changing their lifestyles to ones with less environmental impact.

NIMBY (Not In My Back Yard): “1 Gu 1 Incineration policy” in 1993 proposed by the city but confronted a strong resistance from the public due to the concern on dioxin. Therefore, the citizens must cooperate with the government solution, like Volume-based Waste Fee System (VBWF), Multi-jurisdictional Cooperation on Waste Treatment and Waste as Resources.

Recent legal measures

Recent measures to promote recycling in South Korea include recovery target rates, extension of producer responsibility lists, distribution of distributors and producer responsibilities, and strengthening of local recycling systems. With the development of advanced waste recycling technology, the Government encourages producers to adopt environmentally sustainable technologies by setting up relevant regulation in advance.

4.3.3 CONCLUSION - Level of alignment with CE

It was estimated that 84% of the energy supply in South Korea comes from fossil-based energy sources. South Korea faces environmental resource constraints, which brought the necessity for the country to replace its linear approach with circular economy, as a new economic model [19].

The level can be assessed as 2.

4.4 TAIWAN: REPUBLIC OF CHINA

4.4.1 OBJECTIVES

In order to achieve sustainable recycling of resources and construct a recycling-oriented society, Taiwan refers to the legislation of advanced countries to promote Resource Recycling and Reusing Act since 2013 and fund on circular economy since 2016 significantly. The object of circular economy policy and funding is to strengthen resources recycling, reduction and green design concepts to gradually promote Taiwan's resource recycling to zero waste.

4.4.2 MAIN FINDINGS

Taiwan's circular economy development can be divided into three stages and follow by the issue of environment resources, that is, waste control, energy & water need, resources supply, and sustainable economic development.

The first stage (1950-1990) [20]:

In the duration of agricultural age slowly getting into industrialization, many items tended to be used if possible, in order to save money. The agricultural waste and water and fertilizer produced by agriculture were returned to the agricultural land. This is the earliest circular economy in Taiwan.

An important policy in the first stage was the Waste Disposal Act (Original 28 articles promulgated on July 26, 1974): The original purpose was to solve the problem of environmental sanitation and waste disposal. Now the orientation is on resource supply security and economic development.

No significant funding on circular economy-related research and innovation in the first stage.

The second stage (1980-2015) [20]:

With the development of industrialization and the improvement of economic conditions, the amount of general waste and commercial waste has also increased. During this period, the Taiwan Environmental Protection Agency and the Ministry of Economic Affairs respectively implemented the so-called "3R" and "clean production" to reduce the amount of general waste and upgrade manufacturing industries. The potential of domestic resource recycle and reuse business also increased year by year.

Important policies and/or action(s) in the second stage were following

For general waste

- Four-in-one action for the recycling of resources (1998): the classification of household waste by the “community people” and followed by the recycling by the “local government cleaning team”, “recycling business”, and “recycling funds”.
- Resource Recycling Act (Original 31 articles promulgated on July 3, 2002): This Act is formulated to conserve natural resources, reduce waste, promote recycling and reuse of materials, mitigate environmental loading, and build a society in which resources are used in a sustainable manner.
- Since 2005, the classification of household waste has been enforced and divided into three categories including recyclable resources, kitchen waste and garbage. In addition, some counties and cities executed the garbage-bag fee programme also enhance the recycling willing of people.

For industrial waste

- The Policy for Environmental Science and Technology Park (2002): the policy is oriented to assist local governments to set up environmental protection science and technology parks and use regional industrial symbiosis to promote the development of emerging environmental protection industries. Consequently, recycling industries have been successfully developed in two of the top industrial cities, Taoyuan and Kaohsiung city, not only on waste reducing but also on the consumption of energy and water resources.

For both general and industrial waste

- Resource Recycling and Reusing Act (draft passed on July 25, 2013): Since 2008, the OECD has advocated the establishment of sustainable materials management (SMM) mechanisms in various member countries. Therefore, Taiwan EPA has actively introduced SMM and cradle to cradle (C2C) to harmonize the current provisions on the “Waste Disposal Act” and the “Resource Recycling Act” to gradually promote Taiwan’s resource recycling to zero waste.

No significant funding on circular economy-related research and innovation in the second stage.

The third stage to the future (2000-2050) [20]:

The circular economy during the third phase emphasizes the cycle of high values and the improvement of resource efficiency. New technology research and development allows recycled materials to make better products, better classification, in the recycling system to increase the amount of recycling and make the recycled materials be much valued. Also, the new business model decorated by designer to allow more consumers to accept products made from recycled materials.

Important policies and/or action(s):

- Transformation of the Environmental Protection Agency into the Ministry of Environmental and Resource for integrating the conservation and utilization of various resources more efficiently.
- The EPA has now expanded its past 3R management strategy to 6R. It means 3R will plus Energy Recovery and Land Reclamation, and Redesign. Three goals are:
 - The goal of “source reduction” in 2020 is set on the use of recyclable or renewable materials in production, consumption, waste management, and secondary materials markets in priority.
 - The goal of “green production consumption” in 2030 will impose a certain proportion of recyclable or renewable materials in production, consumption, waste management, and secondary materials markets.
 - The ultimate goal on “material circulation totally” by 2050.

Main funding for circular economy-related research and innovation in the third stage [21]:

The third stage is characterised by funding from divers ministries and institutions.

The funding from Ministry of Economic Affairs: the top year is 2017- 108 million € (technology development: 47%, international exchange: 31.5%, application: 19%, fundamental research: 2.6%) (See Figure 2)

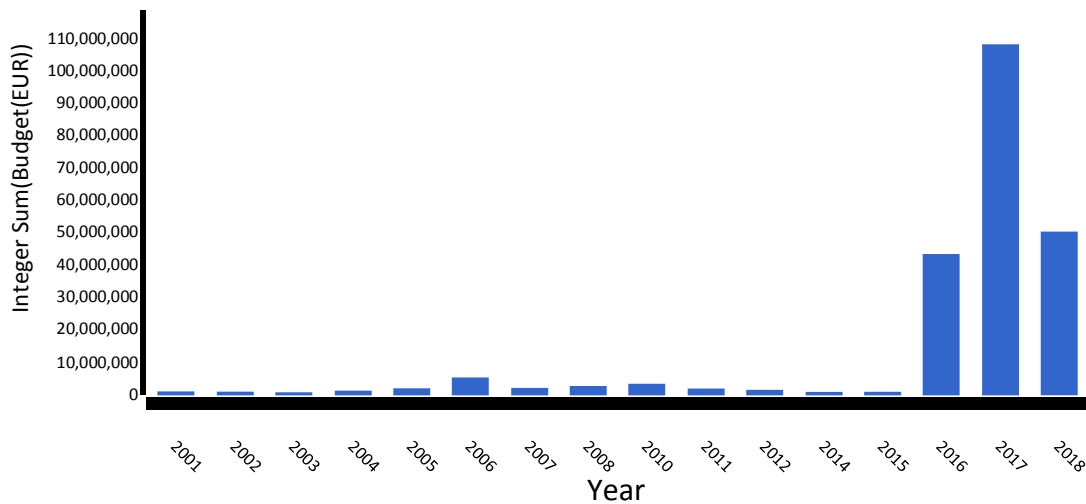


Figure 2: funding from Ministry of Economic Affairs

The funding from ministry of science and technology: the top year is 2017 –25,6 million € (application research: 88.5%, technology development: 10.4%, fundamental research: 0.5%, Commercialization: 0.6%) (See Figure 3)

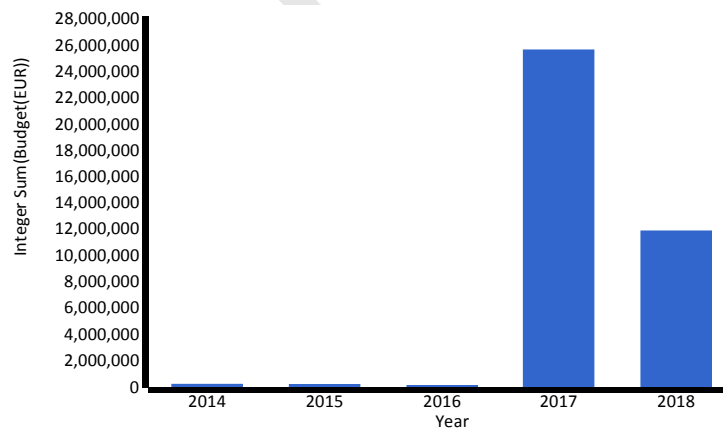


Figure 3: Funding from ministry of science and technology 2014-2018

The funding from Environmental Protection Administration: the top year is 2018 – 0,4 million € (see Figure 4).

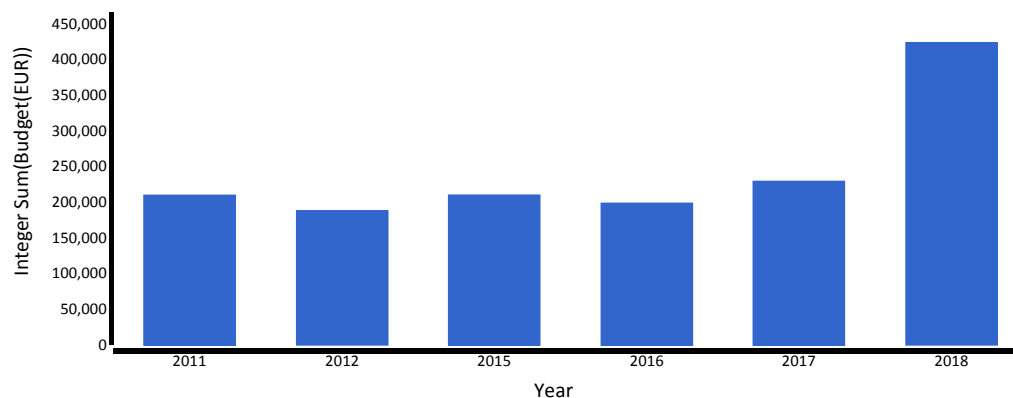


Figure 4: Funding from Environmental Protection Administration 2014-2018

The funding from Environmental Protection Bureau (local government): the top year is 2017 – 1,8 million € (see Figure 5).

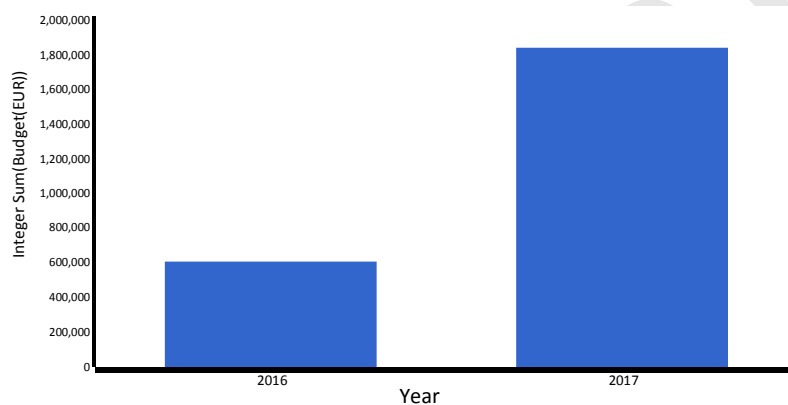


Figure 5: Funding from Environmental Protection Bureau 2011-2018

The funding from Council of Agriculture: the top year is 2017 – 5,3 million € (see Figure 6).

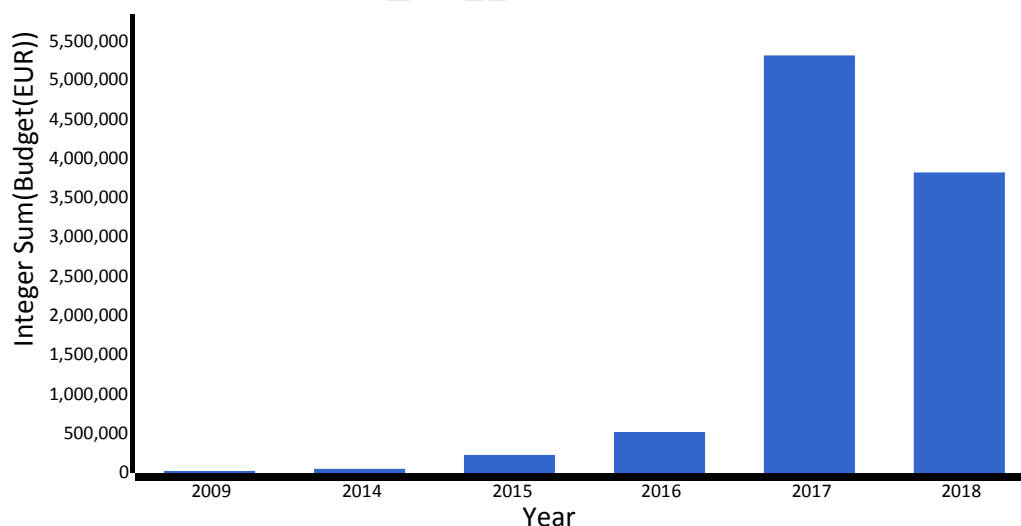


Figure 6: Funding from Council of Agriculture 2016-2017

Another programme is the Four-year Forward-looking Infrastructure Development Programme funding from **National Development Council (Since September 2017)** [23] [24]:

- green energy infrastructure: 231 million € (phase I), 329,6 million € (phase II)
- water environments: 725,6 million € (phase I), 1,7 million € (phase II)

Priority areas: top 10 funding project categories in 2017:

- High value-added Technology Development and Applications Program for Chemical Industry (14,4 million €) (chemicals, water, plastics)
- Planning and Design Criteria for Building Livable Communities with Circular Economy – a Case Study of the Area of Army Maintenance Plant in Xinyi District, Taipei City (12,7 million €) (others)
- Green Circular Economy and Carbon Dioxide as a New Carbon Source for making Innovative Materials (10,9 million €) (chemicals, minerals, plastics)
- Taiwan Design Industry Soaring Plan (7,5 million €) (others)
- Process Scale-Up Project to Shorten Gaps in the Supply Chain for Key Chemicals (7,0 million) (chemicals, plastics)
- Industry Technology Foresight & Intelligence Service (6,6 million €) (others)
- A preliminary research for materials genome initiative (MGI) technology and high performance of structural composite materials (2,4 million €) (chemicals, minerals, plastics)
- Technology Development for Commercialization of Nanotechnology in High Value-added Traditional Industrial-Products (2,4 million €) (chemicals, minerals, plastics)
- Zero waste agricultural carbonization technology innovation (2 million €)(biomass, waste)
- Fine Chemicals Technical Guidance and Industrial Promotion Program (1, million €) (chemicals, water, plastics)

4.4.3 CONCLUSION - Level of alignment with CE

Taiwan is one of the highly industrialized countries around the world. Therefore, the Waste Disposal Act was implemented since 1974. The Resource Recycling Act was also implemented in 2002 in response to the increasing household waste. Although the Resource Recycling and Reusing Act draft has been successfully passed in 2013 to harmonize the previous two acts, this act still can't be promulgated due to the worry of people on the products made of reused resources. Since 2016, the Taiwan government started funding significantly on the circular economy of the industrial resources. In 2017, the Forward-looking Infrastructure Development Program was launched, in which green energy infrastructure and water environments are related to circular economy issue.

The level can be assessed as 3.

4.5 UNITED STATES OF AMERICA

4.5.1 OBJECTIVES

The Circular Economy in the U.S.A. is driven by the private industry. Thus, the goals of the individual companies lie in the competitive advantage that can be achieved by converting to a circular system. Funding initiatives are also financed by the private sector, such as the Closed Loop Fund.

4.5.2 MAIN FINDINGS

In 2014, the U.S.A. generated 258 million tons of municipal solid waste [25] and only 34 % was recycled or composted [26]. Shifting to the circular economy could unlock an estimated 4,0 trillion € in additional economic growth by 2030 and could be the biggest economic revolution in 250 years [27].

The largest players in the circular economy are thus also to be found in the private sector. With Cat Reman, Caterpillar has a global budget of 41,3 billion € and a sale of 7,5 billion € in the circular economy [28]. Caterpillar is thus a pioneer in the circular economy and has been active in this field since 1973 with the founding of Cat Reman. Cat Reman repairs and resells used machinery to reduce waste and resource consumption worldwide.

Of great importance for the Circular Economy in the U.S.A. is also the Goodwill Industries. Material donations are collected and sold again in the company's own stores. Goodwill Industries thus contributes to the Circular Economy in addition to social aid. Revenues in 2012 amount to 3.1 billion € [29].

Many new companies and business concepts are emerging in the U.S.A. that have worldwide significance for the circular economy [28]. An example of this is Lehigh Technologies, which was acquired by Michelin Tires. The company's process works with scraps that already have been stripped of metals and fibers, using liquid nitrogen to turn the remaining rubber cold enough so that it can be pulverized into a fine composite. Lehigh sources that material from tire recyclers or as part of closed-loop arrangements with tire manufacturers [30]. Up until 2019, Lehigh's products have been used to manufacture over 500 million tires using a circular model [29].

Funding is provided primarily through private funding initiatives. With approximately 87,9 million €, the Closed Loop Fund is one of the largest initiatives and with major sponsors such as 3M, Colgate Palmolive, Coca-Cola, Dr Pepper Snapple Group, Goldman Sachs, Johnson & Johnson, Keurig Green Mountain, PepsiCo, Procter & Gamble, Unilever and Walmart, one of the most prominent. They build a fund that provide municipalities with zero-interest loans and private firms engaged in public-private partnerships with below-market interest rates in order to spur investments in recycling programmes and a venture fund for backing early-stage companies and a foundation that funds R&D of technologies and business models focused on building the circular economy.

In addition, there are several initiatives to reduce waste at regional level in the individual states [26]. There are no specific supra-regional government initiatives or support programmes.

4.5.3 CONCLUSION - Level of alignment with CE

A valuation of the state of the U.S. circular economy is quite difficult. On the one hand, there are the globally operating companies with a high reach and a high turnover and the private initiatives, and on the other hand, the public sector is still very weak in the circular economy. 2 is probably the most appropriate rating for the US. If there were even larger supra-regional programmes from the public sector and more restrictions on waste production, a higher rating would also be possible.

4.6 OBJECTIVES FOR INDUSTRIAL COUNTRIES

In most of the considered industrial countries the main objectives for setting up measures supporting Circular Economy were linked with waste management and reducing resources consumption. Economic growth is an objective in the U.S.A. and for Taiwan. Other objectives were addressed only by one country each (see Table 7).

Table 7: Objectives in five industrial countries

Countries / Objectives	Improve waste management	Reduce resources consumption	Climate protection	Support economic growth	Protect the environment	Establish a Circular society / Education
Australia	X	X				
Japan	X	X			X	X
South Korea		X	X			
Taiwan	X			X		
USA	X			X		

4.7 MAIN FINDINGS FOR INDUSTRIAL COUNTRIES

4.7.1 Recent legislation for CE

New recent legislation in industrial countries with focus on circular economy show a widening of the topic for existing programmes in countries with a long experience in this field like South Korea and Taiwan, a prolongation of long existing programmes like in Japan or a totally new orientation like in Australia (see Table 8).

Table 8: Examples of recent legislation in industrial countries

Country	Examples of recent legislation
Australia	Global Leadership Program on the CE (South Australia) CE Policy (New South Wales)
Japan	Fundamental “Plan Sound material-Cycle Society”
South Korea	Recovery target rates, extension of producer responsibility lists, distribution of distributors and producer responsibilities, and strengthening of local recycling systems
Taiwan	3R management strategy expanded to 6R: 3R plus Energy Recovery and Land Reclamation, and Redesign

4.7.2 Examples of funding programmes

Funding programmes identified reach from very specific ones like the Australian programme supporting recycling infrastructures up to very ambitious programmes like the Japanese Fundamental Plan for Establishing a Sound Material-Cycle Society aiming to change the whole society (see Table 9).

Table 9: Examples of funding programmes industrial countries

Country	Examples of funding programmes
Australia	Recycling Infrastructure Grants (Federal State of South Australia)
Japan	Fundamental Plan for Establishing a Sound Material-Cycle Society
South Korea	National Eco-Industrial Park Master Plan
Taiwan	Integration energy and resource
USA	Closed Loop Fund (private)

4.8 CONCLUSION - LEVEL OF ALIGNMENT WITH CE IN INDUSTRIAL COUNTRIES

The level of alignment with Circular Economy in the five selected industrial countries is very high in Japan and Taiwan and high for the others (see Figure 7).

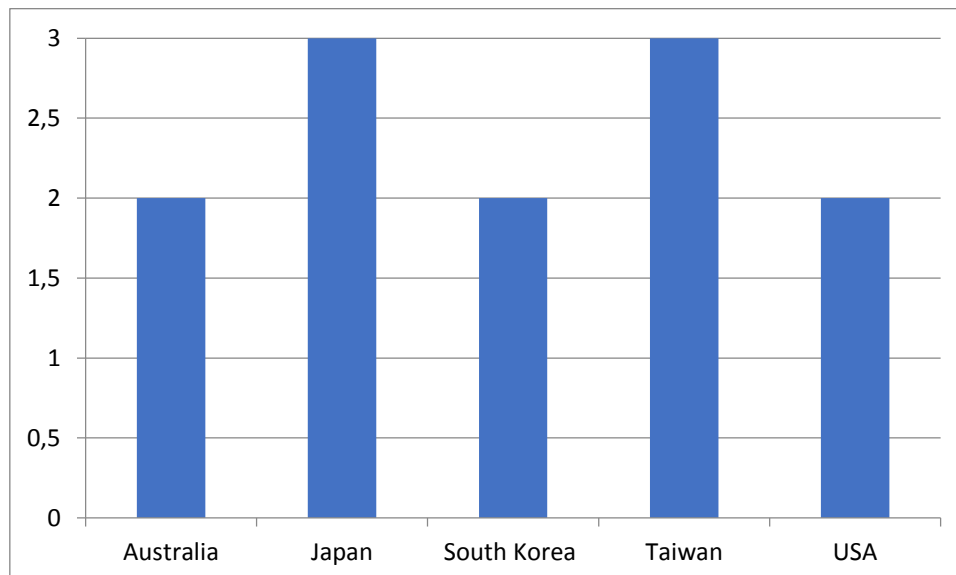


Figure 7: Level of alignment with CE in five industrial countries

5 EXAMPLES OF BRICS COUNTRIES

BRICS Countries are Brazil, Russia, India, the People's Republic of China and South Africa. In some documents they are completed by Indonesia, which changes the acronym to BRIICS. BRICS/BRIICS Countries are very significant for the world economy and even key countries in fundamental issues of Circular Economy, e.g. Material intensity [1].

Three of these countries have been analysed: India, the People's Republic of China and South Africa.

5.1 PEOPLE'S REPUBLIC OF CHINA

5.1.1 OBJECTIVES

The objectives of CE related research and innovation funding programmes in China are to support the scientific and technological research and development in relation to circular economy, the demonstration and promotion of technologies and products in relation to circular economy, the implementation of major circular economy projects, and the development of information services for promoting circular economy. The ultimate goal is to achieve a circular economy in which a closing industrial loops to turn outputs from one manufacturer into inputs for another. [2]

5.1.2 MAIN FINDINGS

Nowadays, the circular economy-related research and innovation in China is based on and greatly promoted by Chinese national policy, laws and regulations.

The concept of Circular Economy in China was introduced in the 1990s. It had origins in cleaner production, industrial ecology, and ecological modernization thinking. The concept of CE was formally

accepted by the central government of China in 2002, when the 16th National Congress of the Communist Party of China legislated Circular Economy as a national new development strategy.

The Chinese perspective on the CE is broad, incorporating pollution and other issues alongside waste and resource concerns, and it is framed as a response to the environmental challenges created by rapid growth and industrialization. In 2004, the National Development and Reform Commission (NDRC) was appointed by the Chinese State Council to take over the duty to promote and implement the circular economy in the country, which meant the Chinese government actually took the circular economy to be an integrated state strategy.

Several Opinions of the State Council on Speeding up the Development of Circular Economy (2005)

In July 2005, Chinese State Council issued the national document *Several Opinions of the State Council on Speeding up the Development of Circular Economy* [3], aiming to develop circular economy in light of the principle of “reduce, reuse and recycle”, take various effective measures to obtain maximum economic output and minimum waste discharge by minimizing resource consumption and environment cost, realize the consistency of economy, environment and social benefit, and build a resource saving and environmentally-friendly society.

In 2005 and 2007, the National Development and Reform Commission (NDRC) and other six ministries jointly organized the first and second sets of circular economy pilot projects, 178 different organizations over the country involved in and pilot projects covering different industries including: steel, nonferrous metals, coal, electricity, chemicals, building materials, light industry, papermaking, textile, machinery manufacturing, agro-processing, agriculture (forestry), processing and utilization base of renewable resources.

Circular Economy Promotion Law of China (2008)

The Cleaner Production Promotion Law of China adopted at the 28th Session of the Standing Committee of the Ninth People's Congress on June 29, 2002. However, China's most important law for pursuing the CE is the Circular Economy Promotion Law of China, which issued in August 2008 and came into force on January 1st, 2009.

The Circular Economy Promotion Law of China [4] is considered as “the world's first national law proclaiming an economy model” different from the mainstream model. Regarding funds for circular economy research, the statement in the Circular Economy Promotion Law is as follows:

Article 42 The State Council and people's governments of the provinces, autonomous regions and municipalities directly under the central government shall establish relevant special funds for promoting circular economy to support the scientific and technological research and development in relation to circular economy, the demonstration and promotion of technologies and products in relation to circular economy, the implementation of major circular economy projects, and the development of information services for promoting circular economy. Specific measures shall be formulated by the financial department in concert with the general administration for promoting circular economy and other departments concerned under the State Council.

In order to regulate the administration of special funds for circular economy development and improve the efficiency in the use of financial funds, and in accordance with the Circular Economy Promotion Law of China and the Budget Law of the People's Republic of China and other laws and regulations, the *Notice of the Ministry of Finance and the National Development and Reform*

Commission on Issuing the Interim Measures on Administration of Special Funds for Circular Economy Development are formulated (The document enforced 2012 and expired 2016) [5].

As per the Measures, the main supporting areas of the fund include:

- Construction of the national “urban minerals” demonstration base. The term “urban minerals” refers to the recycling of waste electrical and mechanical equipment, wire and cable, communication tools, automobiles, home appliances, electronic products, metal and plastic packaging materials, etc.
- Resource utilization and harmless treatment of kitchen waste, including: Construction of the kitchen waste collection and transportation system; Resource utilization and harmless treatment project construction; Capacity building.
- Demonstration of circular transformation of industrial park, including: Construction of key replenishment projects for recycling; Construction of public service facilities.
- Re-manufacturing. The term "re-manufacturing" refers to the mass production process for the professional repair of used automobile parts, construction machinery, machine tools, etc., and the remanufactured products shall reach the same quality and performance as the original products.
- Demonstration and promotion of clean production technology, including: Technology promotion, which focus on mature, advanced and applicable clean production technologies that can significantly improve the company's clean production level; Demonstration of technology applications.
- Capacity building, including: Circular economy regulations, planning and policy research; Development of standards and catalogues for circular economy; Circular economy development publicity and education; Construction of circular economy management information system; Comprehensive evaluation and statistical system of circular economy development and planning, programme, project review and assessment, acceptance and so on.
- Other key tasks agreed upon by the State Council's comprehensive management department for circular economy development and the Ministry of Finance.

After the expiration of the national document *Notice of the Ministry of Finance and the National Development and Reform Commission on Issuing the Interim Measures on Administration of Special Funds for Circular Economy Development* [4], many provincial and city level local governments in China have upgraded their regulations for the Special Funds.

Notice of the State Council on Issuing the Circular Economy Development Strategy and Near-Term Action Plan (2013) [5]

The Plan was created by the State Council of China on January 23, 2013, where it further embedded the idea of a circular economy into Chinese legislation. The plan outlined three levels of circular economies in China, being within a company, industrial park and city or region. The plan outlines various targets for 2015, where they are meant to address both industrial and social sectors.

In the Chapter 7 of the Plan, there is description of the “10-100-1000” demonstration plan. “10” refers to the projects in ten demonstration areas:

- resource comprehensive utilization demonstration projects;
- industrial park circular transformation demonstration projects;
- demonstration projects for renewable resource recovery system;

- demonstration projects for „urban minerals” base construction;
- demonstration projects for remanufacturing industrialization;
- demonstration projects for kitchen waste resource utilization and harmless treatment;
- demonstration projects for collaborative resource utilization and waste treatment in production process;
- agricultural circular economy demonstration projects;
- circulative service industry demonstration projects;
- resource recycling technology industrialization demonstration and promotion projects.

“100” is to select about 100 cities (counties) in China to create national circular economy demonstration city (county). The demonstration cities (counties) should implement the circular production mode and the green consumption mode and take the lead in constructing a resource recycling system covering the whole society.

“1000” is to choose 1000 outstanding enterprises or industrial parks to establish circular economy model. Indicators such as resource consumption, energy consumption, material consumption, water consumption, comprehensive utilization rate of industrial waste, etc. should be evaluated when selecting the enterprises or industrial parks.

When implementing the “10-100-1000” demonstration plan, the investment would mainly depend on the enterprises themselves, but governments at all levels will provide necessary financial support through existing policies and funding channels.

In the Chapter 8 of the Plan, there is one section about strengthen technical and service supporting. While in the Chapter 8 of the Plan, the listed pilot project areas need lots of research and innovation work. In April 2015, to make sure achieve the target set up by the Plan, NDRC issued the *Plan for the Promotion of Circular Economy in 2015*.

13th Five-Year Plan of China (2016-2020)

China's 13th Five-Year Plan (2016-2020) was legislated on March 15, 2016. The key goals of the 13th Five-Year Plan include promoting circular production to establish a circular economy at all levels in society, creating a circular development system with new resource strategies, reducing waste and consumption, increasing resource efficiency, and supporting green initiatives.

Following the 13th Five-Year Plan, fourteen ministry departments of China including the National Development and Reform Commission have jointly issued the Initiative to *Guide the Shift towards Circular Development* [8] in April 2017, which detailed the circular economy development plan as per the 13th Five-Year Plan. The Plan and Guide set up national targets to be achieved, e.g. expects resources productivity to increase by 15% from 2015 levels, while the utilization rate of industrial solid waste should reach 73%. 75% of national industrial parks and 50% provincial industrial parks should be practicing complete circular strategies by 2020. Also includes strategy for promotion of circular economy-related research and innovation.

Main funding for circular economy-related research and innovation in China

The main funding sources for circular economy-related research and innovation in China include:

- a) Special Funds for Promoting Circular Economy from central and local government as per the Circular Economy Promotion Law of China. The funding range is different from province/city to province/city, from industry to industry.

b) Ministry Department Funds for Promoting Circular Economy, like:

- Resource Conservation and Environmental Protection Division, NDRC
- Energy Conservation and Comprehensive Utilization Division, Ministry of Industry and Information Technology.
- Ministry of Science and Technology (MOST).
- Take the MOST "2018 National Key Research Projects on Solid Waste Resourcization" for example, there are 38 projects got funding range from 14.7 to 28.2 million RMB (1,9 to 3,6 million €, project period 36-50 months).
- National Natural Science Foundation of China (NSFC).

For MOST and NSFC Projects, there is National Science and Technology Information System, Public Service Platform providing information searching. Besides, there is international funding available for circular economy-related research and innovation in China, e.g. WWF, WRI, World Bank, Energy Foundation.

Main players in the economy-related research and innovation in China

Except for Companies, there are lots of Universities, Circular Economy Research Institutes, Associates that are active in the economy-related research and innovation in China. For example:

a) National Level:

- Development Research Center of the State Council (DRC)
- China National Institute of Standardization
- China Association of Circular Economy
- Center for Chinese Circular Economic Assessment and Environmental Forecast, China Academy of Social Sciences
- Cleaner Production and Circular Economy Research Center, China Research Academy of Environmental Sciences

b) Provincial Level:

- Beijing Modern Research Institute of Recycling Economy
- Shanghai Circular Economy Association
- Sichuan Province Cycle Economy Research Center
- Circular Economy Public Service Platform of Jiangsu Province
- Shandong Province Circular Economy Association

c) Universities:

- Tsinghua University Centre for Industry and Circular Economy
- Institute of Circular Economy, Beijing University of Technology
- Institute of Circular Economy, Shanghai University
- Circular Economy Research Institute, Tongji University
- Circular Economy and Low Carbon Development Research Center, Nankai University

5.1.3 CONCLUSION - Level of alignment with CE

In the past 20 years, China has made a great achievement in the development of circular economy by set short-term and long-term strategies with clear targets, introducing financial measures, issuing laws and regulations. And an innovation system combining industry, university and research has been formed for CE promotion, even though there are still room left for perfect. [3] [4] [5]. The level can be assessed as 3.

5.2 REPUBLIC OF INDIA

5.2.1 OBJECTIVES

Rapid growth and urbanisation in India have put stress on natural resources, creating negative externalities on societies in terms of water scarcity, limited land availability and insufficient energy generation. Indian culture of living incorporates reuse and recycle of resources to a great extent, mostly in the form of an informal sector for example, rag pickers who separate out valuable materials from mixed household waste dumped at the landfills. The need now, and thereby the objective of several programmes, is to educate and formalize this sector in order to create strategic business models for effective implementation while saving the livelihoods of the people involved.

India is keen to opt circular economy pathways for long-term sustainable growth of the country. However, policies and regulations which consider circular economy principles lack execution, and therefore, funding programmes and schemes act as economic incentives and give the needed push to the industrial sector. The aim of such economic schemes is to facilitate global competitiveness of the industrial sector while incorporating environmentally friendly technologies.

5.2.2 MAIN FINDINGS

The most well-known programme is the 'Swachh Bharat Abhiyan' (Clean India Mission) wherein a large amount of funding has come from the Central Government to clean up Indian streets, encourage adoption of sustainable sanitation practices, and develop better solid and liquid waste management systems for cleanliness in the cities. Another current focus in India is municipal wastewater treatment – many areas in India lack a wastewater treatment plant, and most of the treatment plants that exist have only a primary treatment system. The current projects therefore focus on both building of new plants and the upgrading of existing plants. However, the provision of capital is limited, and the business model is that a tender is issued by the municipality, and the company with the best bid wins the project.

With respect to specific funding programmes, majority of the funding comes from international sources such as the World Bank, Asian Development Bank and European Commission. Such funding programmes span over Asia in general and therefore it is difficult to estimate how much of the funding was directed towards India, but we have tried to give the best estimates as per the information we have received from several sources. The programmes from the European Commission are unique in terms of focus on the early stages such as design, procurement and decision making as compared to other programmes where a large proportion of the funds is utilized for recovery/recycle/collection and end-of-life stage [6], [7].

In some of the international funding programmes, the Indian Department of Science and Technology and the Department of Biotechnology often collaborate with international partners to provide collaborative funds, and such programmes require collaboration between Indian and non-Indian partners [8].

The Government of India has issued various schemes to promote integrated and sustainable industrial development; however, the funds are often underutilized. The main barrier reported in various cases has been the extended amount of time required for statutory approvals and clearances. As a result, the private sector has stepped up and initiated its own actions. One such programme is the Adar Poonawalla Clean City Initiative, wherein the parent company, 'Serum Institute of India', has

decided to clean up its hometown of Pune and has invested heavily in technology, equipment, and awareness raising in the sector of solid waste management.

The national policies and rules have been updated in the last five years considering circular economy aspects, such as producer responsibility for certain waste components, water recycle and reuse, use of refuse derived fuels as a replacement of fossil fuels in the industry. However, the implementation of such policies is lacking to a large extent. The responsibility for execution of the policies falls upon regional and local stakeholders and actors and therefore the implementation of circular economy in India widely varies between different regions.

5.2.3 CONCLUSION - Level of alignment with CE

The rapid economic growth in India has highlighted the problem of limited resources especially land, water, and energy and consequently these are the focus for circular economy programmes. Resource management in India is still at an early stage, with majority of the activities focusing on collection and recovery, and little attention directed towards product design and sustainable procurement.

The proportion of funds being invested by the private sector in circular economy initiatives is on a rise. The corporate social responsibility keyword has caught attention in India in the recent years, and such funds would be more efficiently utilized as compared to public funding.

The 'circular economy' concept is at an evolution stage in India where increasing participation from the private sector would be a key for sustainable development of the country. The level can be assessed as 2.

5.3 REPUBLIC OF SOUTH AFRICA

5.3.1 OBJECTIVES

Most of the regulation and policies in operation in South Africa are generally focused on climate change mitigation, the Green Economy (including Green jobs) and waste management (recycling focused). The concept of circular economy is relatively new in the country and there has not been a strong focus on this specific topic in national level.

5.3.2 MAIN FINDINGS

South Africa has a strong commitment towards growth and the creation of jobs (in line with its National Development Plan [9] and the country's New Growth Path [10]), and a high-profile engagement with the green growth [18] in line with its Green Economy Accord [11]. Because of the country's severe environmental degradation and resource depletion challenges [12] most of the regulation and policies in operation are generally focused on climate change mitigation, the Green Economy and waste management [13]. The government of South Africa is encouraging the development of green industries as a mean to increase investment in the country and the number of people in employment [14].

Since 2008, dedicated waste management legislation has been in place in the country through the "Waste Act" (NEM:WA Section 59 of 2008) including some high level waste prevention strategies [15], but these are to date not really enforced [14] however some waste types were declared as "priority wastes" to deal with. In 2011, a National Waste Management Strategy was approved by the government as a response to fast growing rates of industrial development in the country and with the objective to increase existing waste management efforts [16] by following an integrated waste

management hierarchy which emphasizes “reducing, reusing and/or recycling waste” over disposal. However, the re-thinking /redesign aspects have been limited.

In 2017, the National Department of Environment (DEA) announced its intention to call for Extended Producer Responsibility (EPR) in paper and packaging, waste electrical and electronic equipment (WEEE) and lighting [17]. There are several proposals and plans presented to the government but they have not yet been integrated into the government policy and legislation [13]. Integration of the informal sector (informal waste pickers and recyclers) into the formal waste management strategies and policies, has been considered in many of these proposals [13]. For a number of years, the country has been active in creating waste recycling infrastructure with city councils in Cape Town and Johannesburg introducing domestic collection of waste [14].

South Africa has an active National Cleaner Production Centre (NCPC) [18] as a national programme of the government. This NCPC delivers support on resource efficient and cleaner production (RECP) methodologies to assist a large segment of South African industry to lower costs through reduced energy, water and materials usage, and waste management [16].

In 2013, South Africa’s (and Africa’s) first industrial symbiosis programme was rolled out in the Western Cape Province. This was expanded to other provinces (2014 onward) in collaboration with the National Cleaner Production Centre.

Energy sector has been one of the main focus areas of the country and an electricity infrastructure development plan (Integrated Resource Plan [19] (IRP) 2010-2030) was designed based on least-cost supply and demand balance taking into account security of supply and the environment (minimization of negative emissions and water usage) [16]. The NCPC has also recently announced its intention to establish a Professional Body for RECP practitioners and it will be launched in September 2019 named “RECP Recognition Association”.

The South African Department of Science and Technology has identified the Circular Economy as an unexploited source of growth [20]. The Science, Technology and Innovation policy aims to facilitate a knowledge-based economy (an economy that is supported by the continued expansion of human capital and knowledge base needed for economic growth and social wellbeing in a changing global context), it is thus important for the DST to understand the human capital gaps that exist and the knowledge that is required for South Africa to exploit CE opportunities. Based on this the DST has developed a CE Research, Development & Innovation (RDI) Needs Assessment to identify the research agenda to develop a socio-economic CE evidence base needed for decision makers to make the transition.

In parallel to the governmental efforts to promote the green economy, there are international programmes that support the transition of South Africa to circular economy [14]. Programs funded or implemented by the European Commission, United Nations and German Development Agency (GIZ) are some of the examples. One of the important international initiatives was the African Circular Economy Alliance (ACEA) [21] which is a collaboration between the governments of Rwanda, Nigeria and South Africa with the aim to encourage African countries to collaborate and support each other in adopting to circular economy policies and practices.

South African experts and professionals are actively involved in international and regional networks such as the Circular Economy Club [22] and African Circular Economy Network [23] (ACEN). Through these networks, best practices will be promoted, knowledge will be shared, and local initiatives will

be supported. Moreover, in the private sector, there are many SMEs, consulting companies, initiatives and projects contributing to the implementation of circular economy practices in the country. Many of these have a focus on waste (recycling and re-use as a resource), remanufacturing, renewable energy and water [13], [25].

5.3.3 CONCLUSION - Level of alignment with CE

While the concept of circular economy is relatively new in the region, South Africa is among the main countries in the continent (together with Kenya, Nigeria and Rwanda) which is moving towards implementing circular economy practices [16]. This is specifically needed for South Africa because of its dependence on primary resources and metals, which is currently governed by linear policies and practices.

For African countries, transition to a circular economy is strongly dependent on the lessons learnt and principles developed in European countries. The important point to consider is that the design, strategy and implementation of circular economy will be different in Africa due to the differences in regional socioeconomic and cultural needs [14] [25]. For South Africa, social and environmental issues are the most important drivers towards circular economy; economic considerations have been recently included in the list of priorities. This is for example demonstrated by the human-embedded interpretation of the traditional Ellen McArthur Foundation “Butterfly diagram” that was conceptualized by a founding member of ACEN and is widely supported in Africa ever since [26].

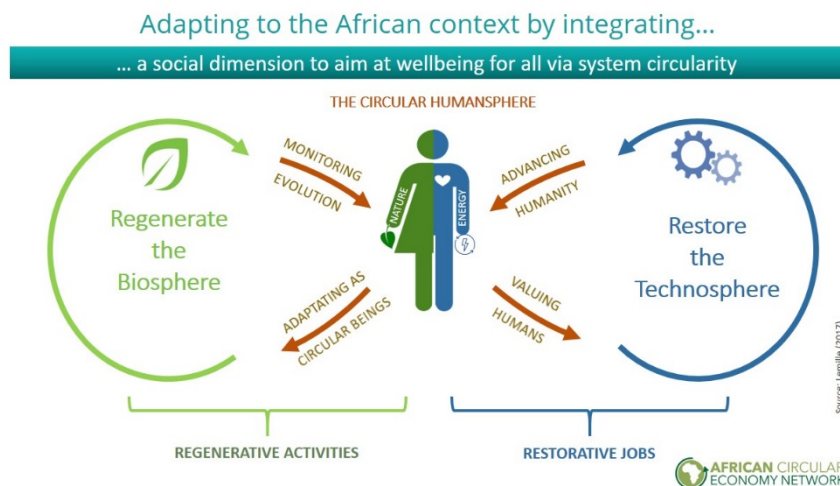


Figure 8: Adapting to the African context by integrating human resources into the traditional Ellen McArthur Foundation “Butterfly diagram” [26]

While designing and implementing circular economy practices in developed countries, the benefits for the developing countries should be included in the first step [13]. There is need for more research on how to implement or adopt European policies in the African countries in order to achieve the best local impact. With this, local constraints, opportunities and resources can be identified and target oriented solutions, roadmaps, legislation and policies can be designed [14]. This requires a broad collaboration between international organizations and national authorities, research institutes, networks and businesses [14]. Based on the information collected for this research, the circular economy alignment in South Africa can be considered at 1.5.

5.4 MAIN FINDINGS FOR BRICS COUNTRIES

5.4.1 Recent legislation for CE

New recent legislation in BRICS countries with focus on circular economy show a widening of the topic for existing programmes in countries with a long experience in this field like the People's Republic of China and a new orientation like in India or South Africa (see Table 10).

Table 10: Examples of recent legislation in BRICS countries

Country	Examples of recent legislation
India	<ul style="list-style-type: none"> Extended Producer Responsibility Law on e-waste adopted in 2016 by the Ministry of Environment, Forest and Climate Change Policy on water reuse in Maharashtra: Reuse the treated wastewater to cool thermal power plants, serve industrial estates, and other non-potable purposes Use of RDF regulated in industrial units under Solid Waste Management Rules 2016
PR China	<ul style="list-style-type: none"> On January 21, 2019 the State Council of China issued the Work Plan for the Pilot Programme of "Zero Waste Cities". Construction of the pilot zero-waste city project is of great significance to promote and deepen comprehensive reform of urban solid waste management, and an important measure to realize an ecological civilization and build a beautiful China. It aims to be a replicable program that realizes the nation's zero-waste target. <ul style="list-style-type: none"> * Ten cities will be selected as pilots, with a comprehensive consideration of region, development level and local industry. By 2020 they are expected to have established a comprehensive management system for waste and to be demonstration models for zero-waste cities. * Establish a national consistent statistical system for solid waste * Promote green mining (key sectors: coal, nonferrous metal, gold, metallurgy, chemicals, non-metallic mining), green supply chain and solid waste recycling (key sectors: battery, electronics, automobile) China's 13th Five-Year Plan (2016-2020) was legislated on March 15, 2016. The key goals of the 13th Five-Year Plan include promoting circular production to establish a circular economy at all levels in society, creating a circular development system with new resource strategies, reducing waste and consumption, increasing resource efficiency, and supporting green initiatives.
South Africa	Western Cape Green Economy Strategy Framework: Green is Smart (2013) - This framework is the Western Cape's roadmap to become the leading green economic hub on the African continent. Currently National Government also develops broad National CE guidelines that are hoped to inspire change in this direction. Also the Carbon Tax Act is now finally legislated (Carbon Tax Act No 15 of 2019) aiming at reducing industrial green-house gas emissions of key emitters.

5.4.2 Examples of funding programmes

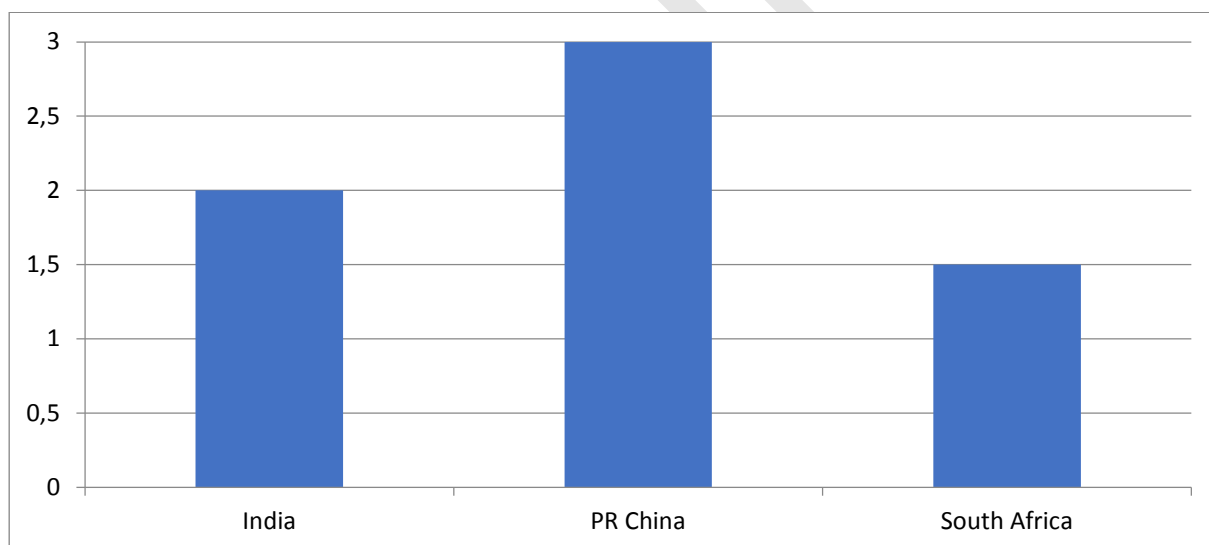
Funding programmes identified reach from very specific ones like the Australian programme supporting recycling infrastructures up to very ambitious programmes like the Japanese Fundamental Plan for Establishing a Sound Material-Cycle Society aiming to change the whole society (see Table 11).

Table 11: Examples of funding programmes BRICS countries

Country	Examples of funding programmes
India	<ul style="list-style-type: none"> • EU-India cooperation in water technology: research and innovation • Adar Poonawalla Clean City Initiative • Swachh Bharat Abhiyan (Clean India Mission) • Switch Asia - Sustainable Consumption and Production • Integrated Processing Development Scheme
PR China	<ul style="list-style-type: none"> • “10-100-1000” demonstration plan • Special Funds for Promoting Circular Economy • Programmes by Ministry of Science and Technology (MOST) • Programmes by National Natural Science Foundation of China (NSFC)
South Africa	<ul style="list-style-type: none"> • Green Fund • Renewable Energy Independent Power Producer Programme (REIPPP) • SWITCH Africa Green Programme (funded by the European Commission)

5.5 CONCLUSION - LEVEL OF ALIGNMENT WITH CE IN BRICS COUNTRIES

The level of alignment with Circular Economy in the three selected BRICS countries is middle for South Africa, high for India and very high for the People’s Republic of China (see Figure 8).


Figure 8: Level of alignment with CE in three BRICS countries

6 EXAMPLES OF DEVELOPING COUNTRIES

Two groups of Developing countries have been analysed: a large group from different continents by ENEA (6.4) and three countries from South America by WRFA (6.5).

6.1 Developing countries cooperating with Italian Republic (“Italy Group”)

6.1.1 BACKGROUND: DEVELOPING COUNTRIES CONTEXT AND GEOGRAPHICAL AREAS

Developing countries have a level of alignment with CE in general lower than advanced countries, as detailed in appropriate section. However European Commission organises circular economy missions, in partnership with business leaders, to promote the benefits it can bring developing countries [1].

In fact, circular economy transition needs a global approach in order to make circular economy a win-win strategy, and EU is one of the largest consuming blocks in the world. For this reason, the private sector, with headquarters in Europe and supply chains extending through the developing world, cannot ignore these countries (also considering that most of them are raw materials producers).

Agreed with this position, the related CE-programmes are mostly cofounded by advanced countries and they involve relevant activities agreed with CE Common Understanding. In particular:

- Cooperating with authorities in implementing initiatives and helping to scope visions for the greening and circularity in regions, cities and communities
- Cooperating with SMEs and industries in developing new solutions
- Co-creating and co-testing of new eco-innovations by users, NGOs, citizens, user groups
- Supporting the dissemination of eco-innovations towards a circular economy

The countries composing the “Italy Group” are listed in Table 12.

Table 12: List of developing countries composing the “Italy Group”

CONTINENT	COUNTRY	Short name
Africa	Federal Democratic Republic of Ethiopia	Ethiopia
	Kingdom of Eswatini	Eswatini
	Kingdom of Lesotho	Lesotho
	Republic of Botswana	Botswana
	Republic of Djibouti	Djibouti
	Republic of the Sudan	Sudan
	Union of Comoros	Comoros
Asia	Islamic Republic of Iran	Iran
	Republic of Maldives	Maldives
Oceania	Pacific Ocean Small Insular Countries	POSIC
America	Republic of Cuba	Cuba

They are based on information obtained through internet research, and key interviews with cooperation programme owners based in Italy, in close connection with key organizations from these countries. Not all countries have concrete findings, as detailed in the appropriate section. However expected results and overall background with focus on circular economy are presented for each country.

6.1.2 FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA

Country background [7]: Even if the Federal Democratic Republic of Ethiopia (Ethiopia) is classified as a Developing Country, it is showing interest and effort to sustainability, as a first step for circularity. In fact, Ethiopia has implemented the Millennium Development Goals (MDGs) integrating with its national development frameworks, which spanned the period 2000 to 2015 and registered

remarkable achievements, providing significant contributions to the preparation of the 2030 Global Agenda for Sustainable Development.

Ethiopia has been pursuing pro-poor policies, implementing development plans and programmes with in which global development agendas (such as the MDGs). In particular Ethiopia has accepted and endorsed the 2030 Agenda for Sustainable Development with national commitments and ownership to implement the 2030 Agenda and its sustainable development goals (SDGs) as integral part of its national development framework. Accordingly, with full sense of national ownership, implementation of SDGs has been and is well in progress in Ethiopia.

As practical results, it is notable the implementation of first plant in Africa converting waste in energy [8]. Furthermore, the country is member of African Circular Economy Network [4] and it is supported by UNIDO in order to show the great potential of the eco-industrial park model [9]. It has also different cooperation programme for sustainability, such as Protection and sustainable use of biodiversity commissioned by German Federal Ministry for Economic Cooperation and Development (2015-2019) [10].

Bilateral cooperation with Italy: The programme is ongoing. Main expected results are listed here below:

- Sustainable water management system
- Integrated approach for natural resources, water and agriculture

6.1.3 ISLAMIC REPUBLIC OF IRAN

Country background: The classification of Iran as Developing country is actually under discussion. In fact, although it is considered as an emerging market, Iran can be considered in many ways a developed country: it has strong established industries such as auto manufacturing (capable of producing more than 1 million vehicles per year) and pharmaceuticals (mainly generics). Furthermore, the infrastructure and the education system show an impressive standard, comparable with Europe.

Regarding circularity concept, recycling is one of most explored field by private sector, as demonstrated by Association of Iran Recycling Industries founded already in 2008 [13] and supported the delivery of Iran Waste Management Act [14].

On the other hand, the trade embargo, worldwide imposed by the UN, USA and EU on Iran, has seriously retarded their national economy and the effort in the sustainability field and the organization of waste collection is not that uniform, affecting the recycling strategy.

Bilateral cooperation with Italy: The programme CE-related projects have not started yet.

6.1.4 KINGDOM OF ESOWATINI

Country background [5]: Kingdom of Eswatini is classified as a lower middle-income country with a per capita GDP \$3.500 and GDP of \$6.259 billion. The economy is predominantly agriculture-based with 70 % of the population residing in rural areas and deriving their livelihoods from subsistence agriculture.

The country, nevertheless, classified as developing country, has delivered different economic development strategy aiming to poverty eradication, employment creation, gender equality as well as environmental protection, such as:

- Government's National Development Strategy (NDS)
- Poverty Reduction Strategy and Action Program (2006-2015)
- Economic Recovery Strategy
- Government Program of Action (2013-2018)

The Government of Kingdom of Eswatini has signed wide range of international conventions; it has created a legal and policy framework to translate international commitments to enable its citizens to realize their full potential and implemented the Millennium Development Goals (MDGs).

Furthermore, the Government of Kingdom of Eswatini and the United Nations System are committed to working together in partnership deliver the aspirations of United Nations Development Assistance Framework, catalyzing sustainable changes that will strengthen systems during and beyond the period covered (2016 – 2020).

Bilateral cooperation with Italy: The programme is ongoing and a specific expected result is territory vulnerability reduction in order to prevent climate change extreme event and reduce CO₂ emissions.

6.1.5 Kingdom of LESOTHO

Country background: Kingdom of Lesotho is particularly far from circularity concept. The country has delivered an Environment Act [12] in 2008 to make provision for the protection and management of the environment, the conservation and sustainable utilization of natural resources, even if with limited scope.

The country has been living climate change risks in recent years. Extreme weather events and natural disasters have been more frequent, affecting farming, the country's natural resource base, including water, and biodiversity, affecting the food insecurity, human, animal and crop diseases, as well as environmental degradation. In addition, soil loss and land degradation have increased due to unsustainable agricultural and livestock production practices, adding further pressure to livelihoods in a country with a very limited area suitable for agriculture (less than 10%).

Bilateral cooperation with Italy: The programme projects CE-related have not started yet.

6.1.6 PACIFIC OCEAN SMALL INSULAR COUNTRIES

Country background: The analysis considered 14 countries (Cook Islands, Fiji, Kiribati, Micronesia, Marshall Islands, Nauru, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu e Vanuatu) as a group due to their particular situation (all small insular State in Pacific Ocean), leading a cooperative strategy to solve common environmental issues (i.e. climate change risks due to ocean level increasing).

Bilateral cooperation with Italy: Until now the programme has funded grants for education of local figures in the field of climate change and ocean resource, as National capacity strengthening. Furthermore, first nationwide Marine Sanctuary in Palau has established. Other results in the field of waste and water management are expected.

The programme approach could consider "integrated" at least at political level, due to cooperation between 14 local countries. Furthermore, integrated programmes including energy and resource efficiency are implemented.

6.1.7 REPUBLIC OF BOTSWANA

Country background: Based on Lahti University of Applied Sciences' SWOT analysis [3], about two-third of the country's revenue is from exports, mostly diamonds and minerals that is almost 50% of

GDP (see Figure 9). Low demand and decreasing prices of minerals affects crucially to country exports. The Republic of Botswana imports 70% of its imports from South Africa.

An increase of food and global oil prices raised an annual average inflation a lot during the global crisis 2007-2008 but now it is more stabilized. However, inflation due to reasons mentioned above indicates the lack of versatility of the country's economy. On the other hand, the corruption risk in the country is considered low. Furthermore, it performs in Human Development Index (HDI), much better than its neighboring countries.



Figure 9: Circular Economy potential and attitudes towards CE in Botswana [3]

CE-related programmes are mostly in cooperation with advanced countries. However, Botswana is member of African Circular Economy Network [4] and it actively invests in the sustainability field, involving its Ministry of the Environment, Wildlife and Tourism.

Bilateral cooperation with Italy: The programme is ongoing. The related projects in the field of circular economy are listed here below:

6.1.8 REPUBLIC OF CUBA

Country background [17]: The circularity concept is pretty far in the country; with sustainability limited scope (it has issued in 2002 the National action plan for nutrition). However, according to bi-annual report 'Living Planet Report 2016' issued by WWF the environmental group, Cuba has the most sustainable model of development on the planet, due to its combination of human development and environmental footprint, with a high level of alphabetization and a high level of life expectancy, while using little energy and natural resources. For this reason, among Developing Countries, Cuba is considered a success story.

Bilateral cooperation with Italy: First results are not available yet.

6.1.9 REPUBLIC OF DJIBOUTI

Country background [11]: Djibouti is located in an African region characterized by arid to semi-arid climatic conditions and population exceeding 800.000 inhabitants. Even if it is a developing country, the Government has delivered different national plan dedicated to sustainable development, such as:

- National Initiative of Social Development

- Strategic Framework for Fighting Poverty
- Plan of economic and social development (2001-2010)

Furthermore, the country has implemented the Millennium Development Goals with main objective to reduce the poverty and foster the sustainable economic development integrating environmental protection. In this sense relevant large-scale economic actions are implementing in close connection with the private sector.

Bilateral cooperation with Italy: The first project of the programme CE related is ongoing and it is expected to realize a pilot eco-friendly zero-emission building, as replicable good practice, in order to support the local administration in legislation update.

6.1.10 REPUBLIC OF MALDIVES

Country background [15]: The country has been a development success; enjoying robust growth coupled with considerable development of the country's infrastructure and connectivity. The country's economy is growing (GDP per capita reached 10.005 € in 2017, compared to 179 € in 1978). Maldives' current development challenges stem from risks from climate change, disaster resilience and environmental sustainability with rising levels of solid waste, due to their geographical situation affected by oceans level increasing.

The additional challenge of the country's geography leads to a dispersed population across many small islands, which makes service delivery difficult and can limit opportunities for job creation and economic diversification.

To respond to these challenges, the government initiated the Greater Malé development strategy, involving investments in larger islands for improved basic service delivery, protection of households from the impact of climate change and natural disasters, and creation of economic opportunities.

However, the circularity concept is far to be achieved yet as urgent matters are still to be solved.

Bilateral cooperation with Italy: Expected main findings are:

- Desalinization water plant
- Public awareness on plant and relation between drinkable water and health

6.1.11 REPUBLIC OF THE SUDAN

Country background [16]: Sudan has a very complicated geopolitical situation, affected not only the social development, but also environmental issues. However, Sudan's diverse natural resources can help support economic growth and development and can also be valuable assets in helping to rebuild the Darfur region and other parts of the country that have suffered years of conflict.

Since completing a major environmental assessment of Sudan in 2007, United Nations Environment has established an active country presence and developed a Sudan Integrated Environment Program. UN Environment is working with Sudanese national, state and local leaders, civil society and the international community to encourage the sustainable development of the country's natural resources – with the ultimate aim of assisting the people of Sudan to achieve peace, recovery and development on an environmentally sustainable basis.

Sudan is member of African Circular Economy Network [4]

Bilateral cooperation with Italy: The programme projects CE-related have not started yet.

6.1.12 UNION OF COMOROS

Country background [6]: The Comorian economy is characterized by limited natural resources, a small internal market, low capacity institutions and a narrow export base. This context makes the country particularly vulnerable to external shocks also due to its geographical situation as insular country. However, the Government has launched a process to develop a National Strategy for Sustainable development agreed with the commitments made in Johannesburg in 2002 and in Burkina in 2004, implemented in 2015.

Bilateral cooperation with Italy: The programme is ongoing. The expected results are:

- Improvement of waste management infrastructures
- Improvement in waste collection
- Developing a waste management national strategy
- Public awareness increasing

6.2 COLOMBIA, ECUADOR AND PERU IN A LATIN AMERICAN CONTEXT

6.2.1 BACKGROUND: LATIN AMERICAN CONTEXT

In 2018, Latin America's economic growth eased slightly to 1.1%. With exceptions (Venezuela and Argentina), most countries registered a sound economic performance. The realization of inclusive growth remains however constrained in several countries by endemic issues such as the low level of public education, overloaded health systems, high income inequality, insufficient infrastructure, large informal sectors, low productivity, a lack of legal security and corruption [18].

Latin America looks at Europe for models on CE and at all European Commission concepts [19] and developments in the last decades. These approaches are adapted to the local contexts without losing the essentials of CE; hence, a Latin American version of CE emerges. This regional version includes CE related approaches which in combination promote and enhance the circularity in the countries.

Main approaches related to CE mostly developed and implemented in Latin America, although not always properly enforced as described in the following lines, include: zero waste and extended producer responsibility initiatives [20].

There are several institutions and initiatives in Latin America aiming at raising awareness on circular economy principles [21]. The most important ones are the following:

- National Cleaner Production Centres (NCPCs)
- Life cycle networks
- Circular Economy Club [22]

Five biggest economies in Latin America include Brazil, Argentina, Chile, Colombia and Peru.

The following report analyses the developments in two out of the 5 biggest Latin American economies, Colombia and Peru. This report also includes Ecuador, a smaller and emerging economy, as part of the sample (see Figure 10).

These are neighbour countries which belong to the Comunidad Andina economic and trade region. Bolivia is also part of this economic region but will not be researched in this report.

Findings for these three countries are presented in the next section. They are based on information obtained through internet research, and key interviews with organizations from these countries (e.g. programmes owners, LC networks and NCPCs).



Figure 10: Three Latin American countries focus of this research: Peru, Colombia and Ecuador

6.2.2 REPUBLIC OF COLOMBIA

A very important development in Colombia is the existence since 2018 of the National Strategy on Circular Economy which serves as the basis for improvements in the next years. As of now, most CE related approaches in Colombia refer to zero waste and extended producer responsibility (EPR) (incl. the EPR law) and the setup of take-back systems and recycling facilities for different types of waste. Private sector initiatives (e.g. food and IT sectors) are more advanced than, for example, in Peru and Ecuador.

There is local expertise on CE through the national cleaner production centre (NCPC), the Colombian life cycle network and the network of sustainable companies (REDES-car). Improvements in the agri-food sector for export are especially visible. Considering that the National Strategy on CE was only recently issued, and due to insufficient enforcement, changes towards more circularity are still very limited. In summary, there is a positive trend in Colombia to move towards CE and if the trend continues, more impacts should be seen in about 2-4 years.

Due to several public initiatives and regulations in place supporting circularity with 3 or more years of implementation, some results and impacts are already visible in this country (e.g. in the IT and food sector). Alignment of CE in Colombia can be scored at 2.0.

6.2.3 REPUBLIC OF ECUADOR

CE related approaches mostly developed and implemented in Ecuador mainly refer to zero waste (national waste law, single-use plastics law in one city – Guayaquil) and resource efficiency in the fishing sector (through the WWF programme).

There is limited local expertise (e.g. at the University of Cuenca with a recently launched CE project) on some topics and this is an area that can be enhanced through south-south cooperation. The University of Cuenca can help catalysing training needs. There are several initiatives neither well known at local level nor articulated which confirms the need for networking among private sector, academia and Governmental levels.

In summary, the impact on circularity (more CE) is still very limited but if enforcement and networking [23] is improved impacts should be seen in the long term, in about 3-6 years. Recently the Ministry of Environment has announced the preparation of a White Book on CE in Ecuador [24].

There are less CE related initiatives in this country but very important ones concerning their impact on circularity. Like the Peru situation, CE related approaches are relatively recent so the impacts and changes will only take place in 3 to 6 years-time. CE alignment in this country is also scoring 2.0

6.2.4 REPUBLIC OF PERU

CE related approaches mostly developed and implemented in Peru mainly refer to zero waste and extended producer responsibilities (e.g. waste law, single-use plastics law) and their enforcement, for example, through take back systems in the IT sector and the setup of recycling facilities for different types of waste. There is local expertise through senior organizations such as the national cleaner production centre (Grupo Gea) and the national life cycle network (PELCAN) both with extensive experience. Considering the recent issuing of most relevant regulations (single-use plastics law) and the insufficient enforcement and communication on CE options in the country, the impact on circularity (or CE) is still limited. In summary, there is a positive trend in Peru to move towards more CE and if the trend keeps-up impacts should be seen in about 2-5 years.

Concerning local capacities availability to support the implementation of CE, National Cleaner Production Centres in Colombia and Peru have the skills, resources and the buy-in of the public and private sectors to satisfy the local demand which is still very little.

In Peru, relevant initiatives have been issued or launched only recently (e.g. the single-use plastics law in Dec. 2018), hence, changes and signals of a more circular economy cannot be yet perceived (recycling rates are not high). The policy cycles have 2 to 6 years period, so it is foreseen to have more visible impacts in 2021 and onwards. The CE alignment in this country is scored at 1.5.

6.3 OBJECTIVES FOR DEVELOPING COUNTRIES

The objectives for CE-related programmes in the considered developing countries are summarised in Table 13. A short description per country follows.

Italy Group

- Resilience and adaptation/mitigation actions
- Environmental impact reduction
- Sustainable development promotion
- Common urgent matters are related to waste and water management.

Federal Democratic Republic of Ethiopia

- Forest management/conservation
- Sustainable agriculture
- Water Resource
- GHG Reduction Activities
- Capacity Building and Training

Islamic Republic of Iran

- Development of Greenhouse Gases Mitigation and Adaptation Plans of Action
- Water Management
- Waste management

Kingdom of Eswatini

- Environment and natural resources protection

Kingdom of Lesotho

- Environment and natural resources protection

Pacific Ocean Small Insular Countries

- Sustainable agriculture and water management

Republic of Botswana

- Forest and sustainable water management

Republic of Cuba

- Coastal protection-restoration and tourism development

Republic of Djibouti

- Improved access to drinking water and sustainable integrated water management
- Promotion of sustainable crop and livestock production practices for greater food security and greenhouse gas emission reduction
- Sustainable waste management
- Integrated coastal management
- Sustainable forest management

Republic of Maldives

- Waste management and treatment

Republic of the Sudan

- Promotion of water treatment and sustainable integrated water management
- Integrated coastal management effectiveness
- Reduction of deforestation and forest degradation
- Sustainable waste management

Union of Comoros

- Water treatment, including water desalinization
- Waste management
- Public education and awareness campaigns
- Resources sharing

Colombia, Ecuador and Peru

Circular Economy is not yet officially used in mandatory requirements and only Colombia is referring to it in its national 2030 Roadmap.

Most Governmental related CE initiatives concern waste regulations, and most advanced ones relate to extended producer responsibility (EPR) initiatives and their take-back systems. However, poor enforcement is reducing the chances of improved circularity of the materials (with low recycling rates). Colombia is the most advanced country concerning the application of extended producer responsibility which promotes circular economy in value chains.

Concerning local capacities availability to support the implementation of CE, National Cleaner Production Centres have the skills, resources and the buy-in of the public and private sectors to satisfy the local demand which is still very little. Some universities, as described in each country report are also capable to support countries initiatives.

In Colombia and Peru legislation for controlling single-use plastics have been issued whose impacts on circularity are not visible yet but are triggering product eco-design and innovations especially in the agri-food/packaging sector.

Table 13: Objectives in 14 Developing countries

Countries / Objectives	Improve waste management	Reduce resources consumption (incl. water, sustainable agriculture & forestry)	Climate protection	Support economic growth / job creation (incl. tourism)	Protect the environment	Establish a Circular society / Education
FR Ethiopia		X	X			X
IR Iran	X	X	X			
K Eswatini		X			X	
K Lesotho		X				
Pacific Ocean		X				
R Botswana		X				
R Cuba				X		
R Djibouti	X	X	X			
R Maldives	X					
R Sudan	X	X				
U Comoros	X	X				X
Italy Group	X		X	X	X	
R Colombia	X					X
R Ecuador	X					
R Peru	X					

6.4 MAIN FINDINGS FOR DEVELOPING COUNTRIES

6.4.1 Recent legislation for CE

Examples of recent legislation for CE from developing countries are shown in Table 14.

Italy Group

Based on our research it can be concluded that the CE-related programmes have scopes with limited application to the urgent matters listed above (mainly water and waste management). However, the cooperation with advanced countries matches educational objective. The countries are in general fairly far from CE “advanced concept”.

However, increasing concerns with respect to the resource's availability (i.e. drinking water) together with climate change mitigation need is increasing the cofounding of cooperation programme agreed with general increasing of raising awareness on the need to move towards more circularity.

Furthermore, some countries have issued policies for resource sustainability, milestones for circularity reaching, as summarized as shown in Table 15.

Colombia, Ecuador and Peru

Based on our research it can be concluded that the concept of CE is fairly new in these countries and is applied only since recently and within a limited scope by companies or governments. There is still some resistance in the application of a CE (based on re-use and recycling) as this goes against the traditional economic models in these countries which rely on the extraction of primary resources.

On the other hand, increasing concerns with respect to the availability of resources is leading to raising awareness on the need to move towards more circularity.

Recent CE related developments in these countries include related legislation and national policy frameworks which are important to improve the enabling conditions for more circularity. They can be summarized as follows:

- Circular Economy is not yet officially used in mandatory requirements and only Colombia is referring to it in its national 2030 Roadmap.
- Most Governmental related CE initiatives concern waste regulations, and most advanced ones relate to extended producer responsibility (EPR) initiatives and their take-back systems. However, poor enforcement is reducing the chances of improved circularity of the materials (with low recycling rates). Colombia is the most advanced country concerning the application of extended producer responsibility which promotes circular economy in value chains.
- Concerning local capacities availability to support the implementation of CE, National Cleaner Production Centres have the skills, resources and the buy-in of the public and private sectors to satisfy the local demand which is still very little. Some universities, as described in each country report are also capable to support countries initiatives.
- In Colombia and Peru legislation for controlling single-use plastics have been issued whose impacts on circularity are not visible yet but are triggering product eco-design and innovations especially in the agri-food/packaging sector.

Table 14: Examples of recent legislation in developing countries

COUNTRY	Examples of recent legislation
Islamic Republic of Iran	<ul style="list-style-type: none"> National Implementation Plan for the Stockholm Convention on Persistent Organic Pollutants Iran Waste Management Act
Kingdom of Eswatini	<ul style="list-style-type: none"> Environmental Protection Law Environmental Management Act
Kingdom of Lesotho	Environment Act
Republic of Botswana	<ul style="list-style-type: none"> National Intended Determined Contribution National Adaptation Plan National Appropriate Mitigation Actions National Water Master Plans National Transport Master Plan National Intended Determined Contribution
Republic of Cuba	National action plan for nutrition
Republic of Djibouti	National Initiative of Social Development
Republic of the Sudan	Sudan Integrated Environment Programme
Union of Comoros	National Strategy for Sustainable development
Colombia	<ul style="list-style-type: none"> Law 1672 on Extended Producer Responsibility in e-waste National Strategy on Circular Economy
Ecuador	<ul style="list-style-type: none"> 2018 Ordinance to regulate single-use plastics in Guayaquil Institutional Framework for Environmental Incentives National Program for the Integral Management of Solid Waste (PNGIDS)
Peru	<ul style="list-style-type: none"> Plastics Law 30884 of 2018 (LAW THAT REGULATES SINGLE USE PLASTICS AND DISPOSABLE CONTAINERS). Waste regulation (law 1278 from 2017) considering extended producer responsibility principle

6.4.2 Examples of funding programmes

All identified funding programmes are funded by foreign institutions and address primarily waste (see Table 15).

Table 15: Examples of funding programmes in developing countries

Country	Examples of funding programmes
Italy Group	Cooperation in the field of climate change vulnerability, risk assessment, adaptation and mitigation
Colombia	Sustainable Recycling Industries in Colombia (funded by SECO, Switzerland)
Ecuador	<ul style="list-style-type: none"> Solving the e-waste problem in Latin America (funded by UNIDO) Enhancing the Social Value of the Circular Economy in Latin America (funded by VLIR-UOS, Belgium) Ecuador Mahi (funded by WWF)
Peru	<ul style="list-style-type: none"> Sustainable Recycling Industries in Peru (funded by SECO, Switzerland) Solving the e-waste problem in Latin America (funded by UNIDO) The Sustainable Urban Mobility in Secondary Cities in Peru (funded by GIZ)

6.5 LEVEL OF ALIGNMENT WITH CE OF DEVELOPING COUNTRIES

According to the analyse made for the “Italy Group” and three Latin American countries the level of alignment with CE in these fourteen developing countries is quite high for nine of them, middle for one and rather low for the further four (see Figure 11). There is no difference based on the continent considered.

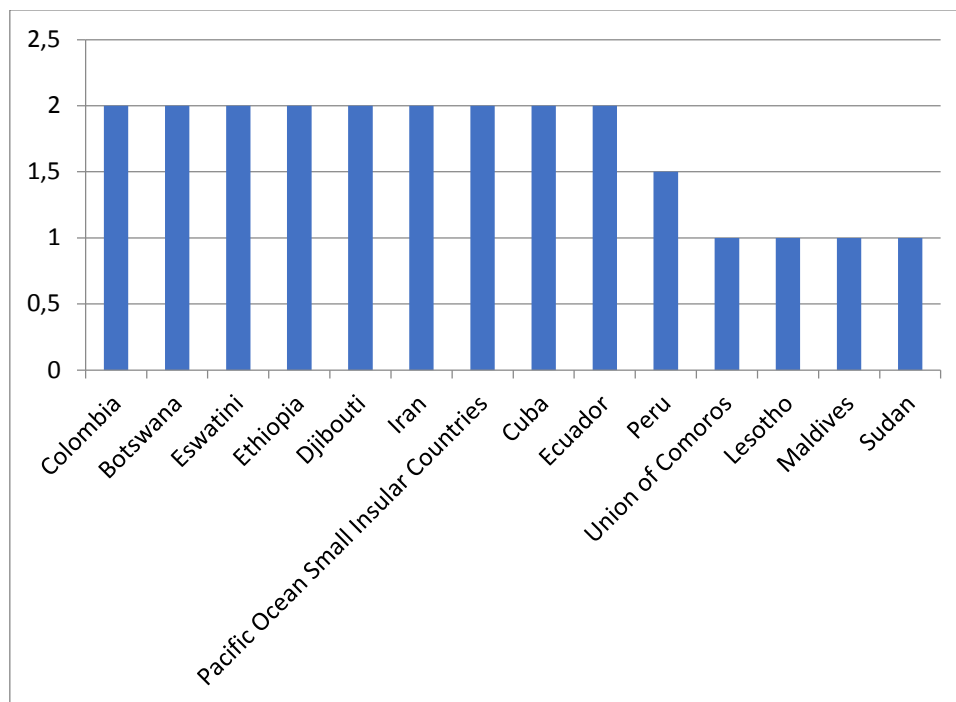


Figure 11: Level of alignment with CE in 14 developing countries

7 FOCUS ON SECONDARY MATERIALS SUPPLY SECTOR

Provision of an overview of technology trends and market conditions in CE relevant secondary materials supply sectors that determine especially key technologies is a report attached to D1.3 prepared by GKZ. The main findings of the report are introduced in this chapter.

The report provides an overview of the international market, and the secondary productions both outside and inside of the EU in order to understand the challenges of the EU industry, particularly its technology development needs. The definition of secondary RM supply in this report refers to those occur in the primary sector and the descriptions are listed as follows.

- Mining / Extraction: solid mining waste, and mining wastewater
- Processing: tailings, solid residues, and by-products
- Smelting: slag, and effluents

Therefore, the technology developments refer to the new developments in mining, processing, refining and smelting that reuse RM waste from the processes or by-products. Particular emphasis will be placed on smelting as metallurgy is a key enabler in CE. Industrial and post-consumer waste streams may be mentioned as complementary information.

The commodities studied in this report include cobalt, nickel, REE and gallium. The selection criteria are not only based on their importance in the conclusion of D1.2, here specifically the two application case studies, domestic energy storage and electric vehicles but also considering the possibility of acquiring first-hand information from SMEs, research institutes and other stakeholders. Due to tin's special metallurgical behaviour as carrier element for a significant number of Critical Raw Material (CRM) for emerging technologies and thus crucial for their recycling process, it is also included in this report.

By comparing the CE performance between the EU and the rest of the world, we found that while cobalt is not recovered from tailings like in the D.R.C. within EU, it is recovered as by-product of the nickel production and from industrial and post-consumer wastes. The EU technology level in both primary and secondary refining remains leading in the world. There are also H2020 projects focusing on recovering cobalt from post-consumer wastes and mine wastes. Specific challenges indicated by Nickelhütte Aue, a local nickel smelter in Saxony, are to economically dismantling Li-ion batteries and the long lifecycle of Li-ion batteries which makes expanding capacity for future needs difficult.

As to nickel, no major nickel production from tailings was found. However, there are currently two H2020 projects dedicated to recover nickel from mine and smelting process wastes. In general, nickel is well-recycled through the exceptionally mature international steel manufacturing industry. The fields needed further R&I development are recovering nickel from Li-ion batteries, urban wastes and ashes, and spent catalysts of the petrochemical industry. Backward-integration is suggested to bridge the bottlenecks in nickel scraps supply.

While tin is recovered from tailings and as by-product during the primary production in the EU, the refining process often takes place outside of the EU. The same situation applied to the South Crofty tin mine (Cornwall, UK) in development. On the other hand, Europe has advance secondary tin refiners specialised in recovering tin from industrial residues. Feinhütte Halsbrücke, a tin smelter in Saxony at SME scale, is currently developing a flexible process capable of treating both the primary and the secondary feeds in the hope for reducing supply risk and accommodating the nearby deposit under development. Regarding the recovering tin from post-consumer wastes, there is only one project from the FP7 period.

In order to reduce the reliance on the import of REE from China, there are active activities scouting new deposits. Within the EU, there are two RE mines and one separation plant in development. There are also three existing separation plants with spare capacities. In addition to the search of new deposits, the global trend is to recover REE from tailings, red muds and processing residues. In the EU, several H2020 and FP7 projects are following the same track. Besides recovering REE from mining and metallurgy residues, there are many EU projects researching on recovering REE from permanent magnets. However, it should be noted that, currently, the greatest source of REE recycling is from scraps of permanent magnet producers in China [1]. Unlike Japan which finds its secondary sources at old air conditioner compressors, hard disk drives (HDD), magnet alloy scraps as it is a major producer of these products, the accessibility of EU refineries to the secondary sources remains a challenge.

In the chapter of REE, a review of the Japanese REE strategies and funding schemes was conducted due to its advance development in this field. Because of the lack of natural mineral resources and the awareness of the supply risk in depending on a single country, Japan launched a comprehensive strategy on rare metals supply security since 2007 after three years of preparation. The core of the

strategy includes overseas mining projects investments, marine resource developments, developing REE alternative materials and consumption reduction technologies, recycling technologies, and stockpiling. Regarding the support of overseas mining projects and marine resource developments, there is well-established public-private relationships between private companies and the public institutions, for instance, Japan Oil, Gas and Metals National Corporation (JOGMEC) which carry out overseas field surveys and provide financial assistance to high risk mine development projects [2]. Technologies using REE alternative materials, reducing REE consumptions and REE recycling were promoted by the Japanese government in basic researches, practical researches and industrial adoption. The Japanese government actively strengthens the collaboration between governments, research institutes and industries. An important example is the collaboration between the Japanese Ministry of Education, Culture, Sports, Science and Technology (MEXT) and its funding agency, JST, establishing basic and strategic research and the Ministry of Economy, Trade and Industry (METI) and its funding agency, NEDO, focusing on applied research.

Primary gallium is typically recovered as a by-product of bauxite and zinc ores. Despite the maturity of the technologies in recovering gallium from the Bayer process, the primary gallium production ceased in Germany in 2016 as the international market price fell below the production cost. The dramatic decrease in the price is mainly due to the overcapacity in China. Due to the same reason, the recycling capacities around the world are expected to drop in the future. Currently, the main recycling feed is the industrial residues from GaAs substrate productions. The recycling operation mostly takes place locally (e.g. within EU). Unlike the industrial residues, gallium containing post-consumer wastes is hardly ever recycled.

Although each commodity has its specific challenges which are illustrated at the corresponding chapters of the attached report, recurrent themes can be found such as requiring processing technologies which accept diverse material feeds (i.e. primary materials, industrial residues and post-consumer wastes) and which recovers multi-elements as by-products. Hence, a special attention should be paid to the backward integration of the secondary refiners (e.g. Feinhütte Halsbrücke) and forward integration of primary refiners (e.g. Freeport Cobalt) in the EU as this development makes local circular economy possible. At the same time, the capability to process various feed sources may lower the supply risk of the refineries and keep them living within Europe.

Metallurgical infrastructures are indispensable for enabling CE [3], for instance, Top Submerged Lance (TSL) furnace and associated refinery technology are capable of recovering many metals. However, as the latest TSL data shown below (Figure 12), while many countries outside of the EU are building new plants in the last 10 years, particularly in Far-East Asia, with only four out of 66 new installations worldwide, the EU investment in this field is not outstanding considering the EU's aim to achieve CE in the near future.

Political or legislative interventions, such as the REACH and specifically lead and copper bans, also challenge producers and recycling companies in the same way. In many cases, production and recycling processes need to be adjusted hard on the limit to economic viability. A principle problem being regarded by many smelting companies is that more and more politics and policies pose production processes and materials supply challenges. The challenges do not always lead to new and more competitive niche inventions, such as the successful replacement of prohibited Cu-Pb alloys with Cu-Si and Cu-Fe alloys, but, for instance, recycling of magnets by shredding and thermal treatment (demagnetisation) resulted in the accumulation of the REE in the slag.

The other framework conditions that the EU should take into consideration are for instance; reducing the knowledge gap by maintaining metallurgical schools, such as Freiberg University of Mining and Technology, and research projects to ensure the deep know-how is transferred to and further developed in the next generation. Another example is to establish CE strategic alliances in international cooperation by fostering the EU's global presence in metallurgical processing and resources.

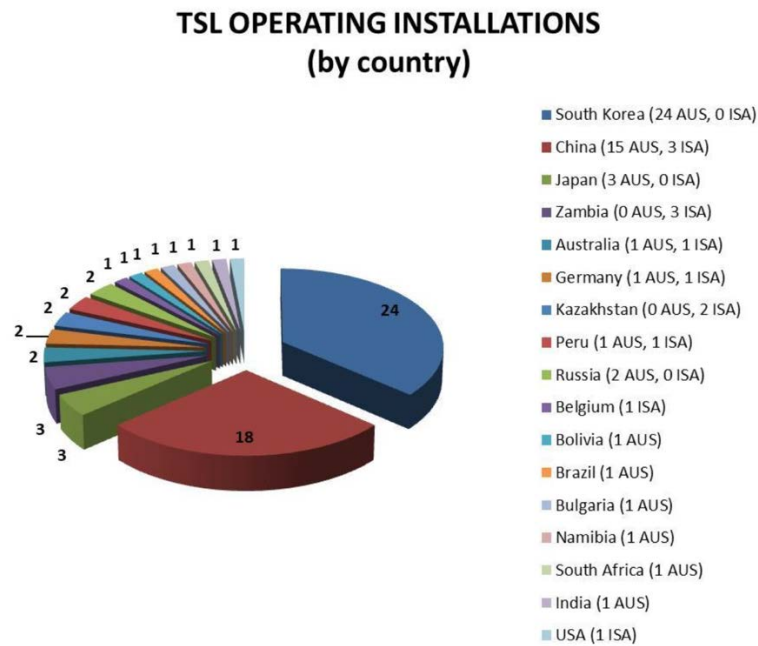


Figure 12: TSL Operating Installations (by country) [4]

8 VALUABLE EXPERIENCES AND LESSONS LEARNT

8.1 OBJECTIVES

Considering all organisations and countries analysed above three groups of main objectives for supporting circular economy can be observed (see Table 16). The first group with the most common objectives includes “reduce resources consumption” and “Improve waste management”. The second group concerns “Establish a circular society” and “Support economic growth”. Two objectives are less common: “Protect the environment” and “Climate protection”. This result may surprise. On the other hand, CE seems to be considered as an economic and societal concept with strong focus on resources / waste management and an environmental / climate component.

Table 16: Objectives in European, international organisations and extra-European countries

Objectives	Improve waste management	Reduce resources consumption	Climate protection	Support economic growth	Protect the environment	Establish a Circular society / Education
European international Cooperation	3	3	3	3	3	3
International organisations	2	3	1	3	3	6
Number of Countries	15	13	5	6	2	4
Total	20	21	9	12	8	13

8.2 SURVEY RESULTS ON FUNDING IN EXTRA-EUROPEAN COUNTRIES

8.2.1 Programme level (source of funding)

Respondents were asked to identify max. 5 of the most important CE (framework) funding programmes and/or measures in the respective country or region and specify the programme level (regional, national, European, international or private). Figure 13 gives an overview of the programme level in the 30 countries analysed. The total number of programmes was 35.

More than half of the programmes (60,0 %) are national programmes. Four of these national programmes (18 %) working in Developing countries are funded by European Member States (Germany, Italy) and by Switzerland. Some programmes (11,4 %) are founded at regional level: in South Australia, New South Wales and the City of Pune (India).

One regional programme is run by the Belgian region of Flanders. The same amount of programmes is funded by the industry (USA). Few programmes are funded by international organizations (UNIDO, WWF) and by the European Union (8,6 % each).

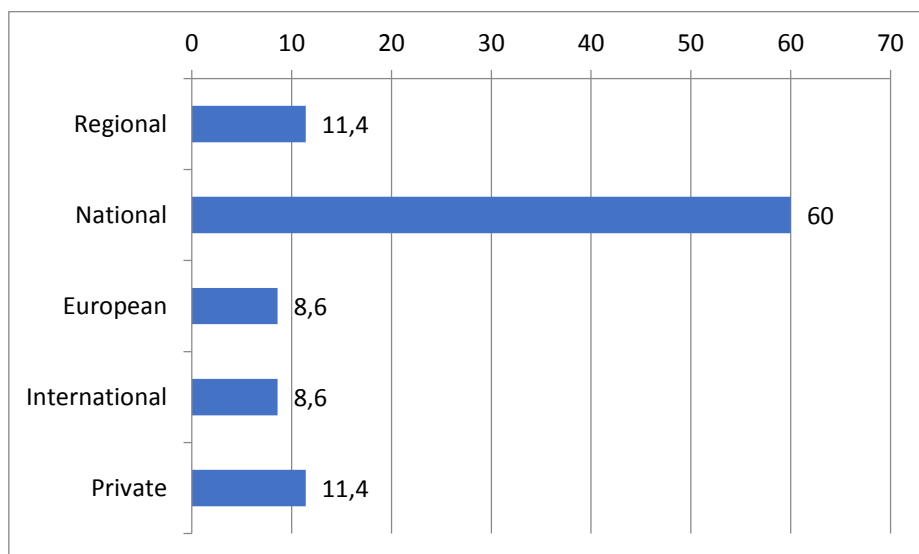


Figure 13: Shares of programme level (in per cent)

Valid cases: 35 programmes; missing cases: 0

8.2.2 Financial volumes

For the programme identified, the overall budget size (or the part of budget allocated to CE) was inquired (Q1.4). Figure 14 depicts approximated figures on the shares of programme disposing of different annual financial volumes. This data was available for about half of the programmes identified. Half of the described programmes (55,5%) have annual financial volumes between lower than 1 million €. A considerable share of programmes (27,8%) is funding more than 1 to 4,9 million € per year. A relevant part of the described programmes is funding more than 10 million € per year (16,7%). No programme was identified in the category of 5 to 9,9 million € volumes per year.

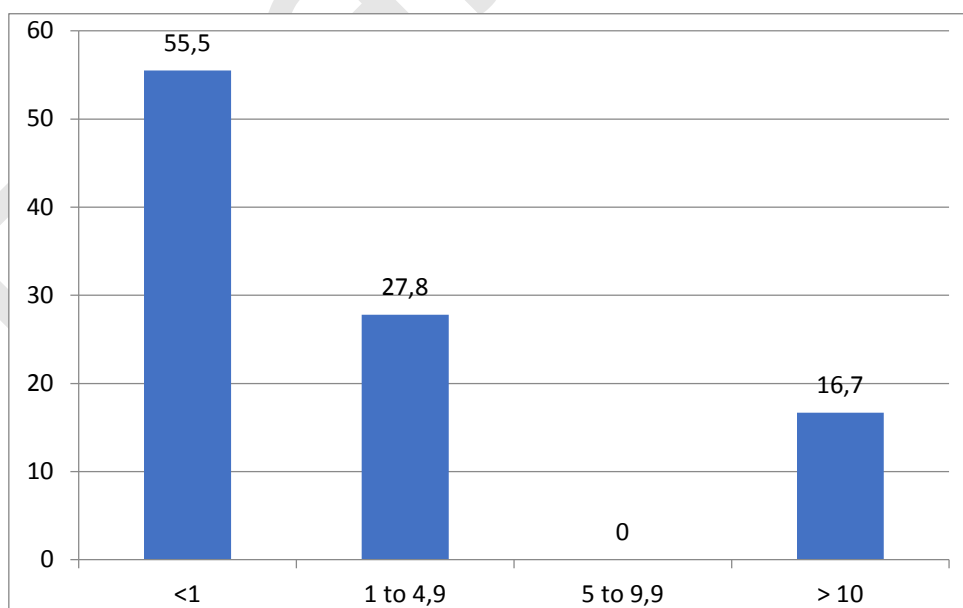


Figure 14: Annual programmes volumes (in per cent of programmes)

Valid cases: 18 programmes; missing cases: 17 programmes missing

When examining the annual financial programme volumes, several challenges had to be addressed, and should be noted by readers:

- Respondents indicated different kinds of data on the budgetary volumes of the programme. In order to include as many programme as possible in the analysis, the authors levelled the obtained data. Thus, data on annual financial volumes were applied, if indicated by respondents. Furthermore, the authors calculated average volumes per year if respondents had indicated the programme duration and the total financial volume of the programme.
- The programmes differ about the funded issues, and not all the programmes described by respondents are exclusively funding circular economy projects. The original figures on programme volumes indicated by respondents as well as the information on the topics funded by the respective programmes are provided separately for each of the included programmes in Table 13 in the Annex.

8.2.3 Funding per project and number of projects funded

The survey results were available for 15 programmes in 17 countries (see Figure 15). The analysis of the Italy Group has been separated from the other countries and presented in Figure 16.

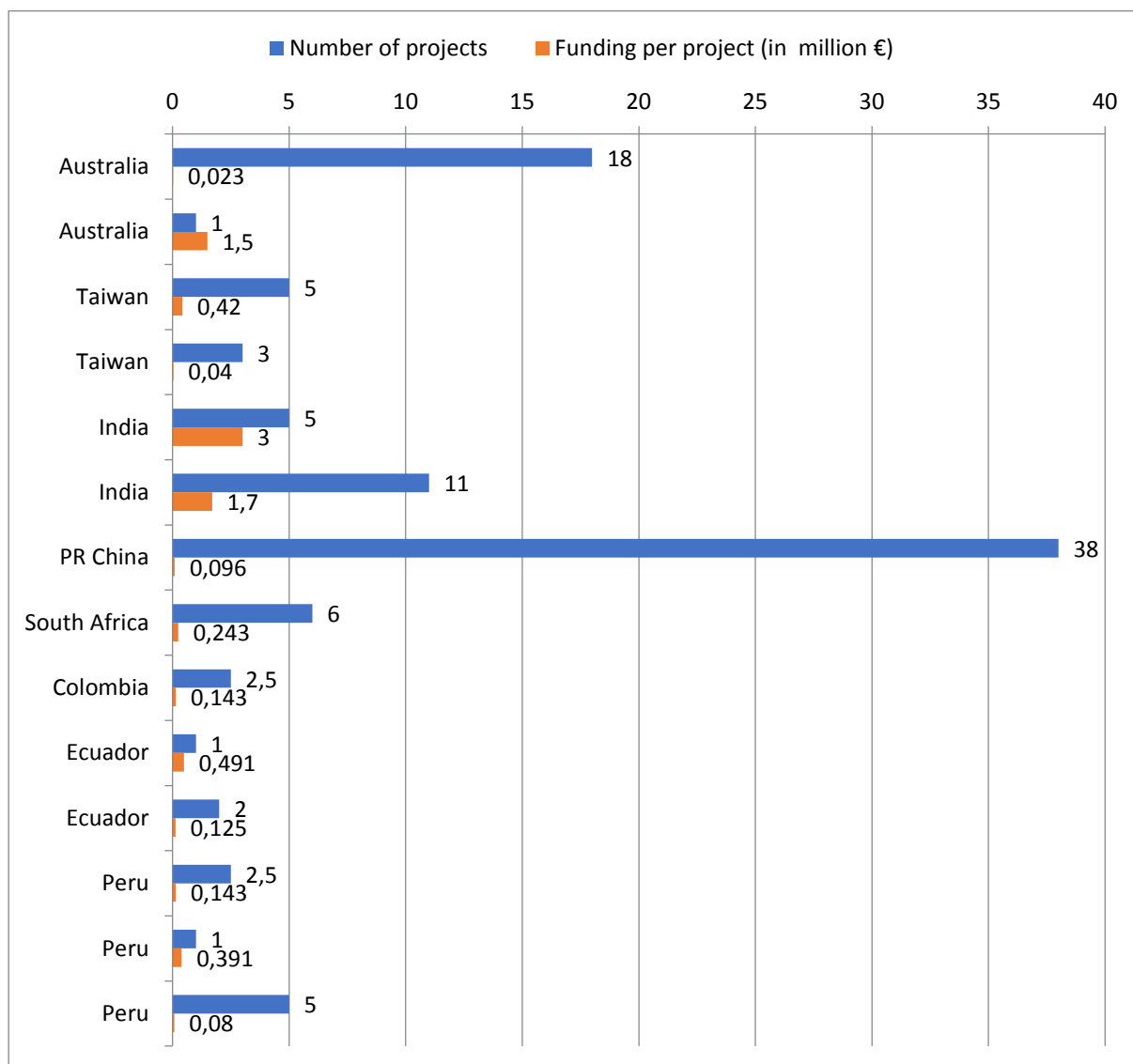


Figure 15: Number of projects and funding per project in 14 programmes in 8 countries

Valid cases: 14 programmes; missing cases: 21 programmes missing

The funding per project in the further 14 programmes from 8 countries analysed ranges from 0,023 to 1,7 million €. In most programmes 1 to 6 projects have been funded. This number reached 38 in the case of a large programme in the PR China, 18 in Australia and 11 in India.

Data were available for 9 from the 11 countries belonging to the “Italy Group”. As this data differed quite a lot from country to country the results are presented in Figure 16.

The funding per project in this Italian programme in 9 countries analysed ranges from 0,075 to 2,25 million €. The number of project funded was in many cases 1 or 2 and reached 24 in the case of the Pacific Ocean Small Insular Countries (POSIC).

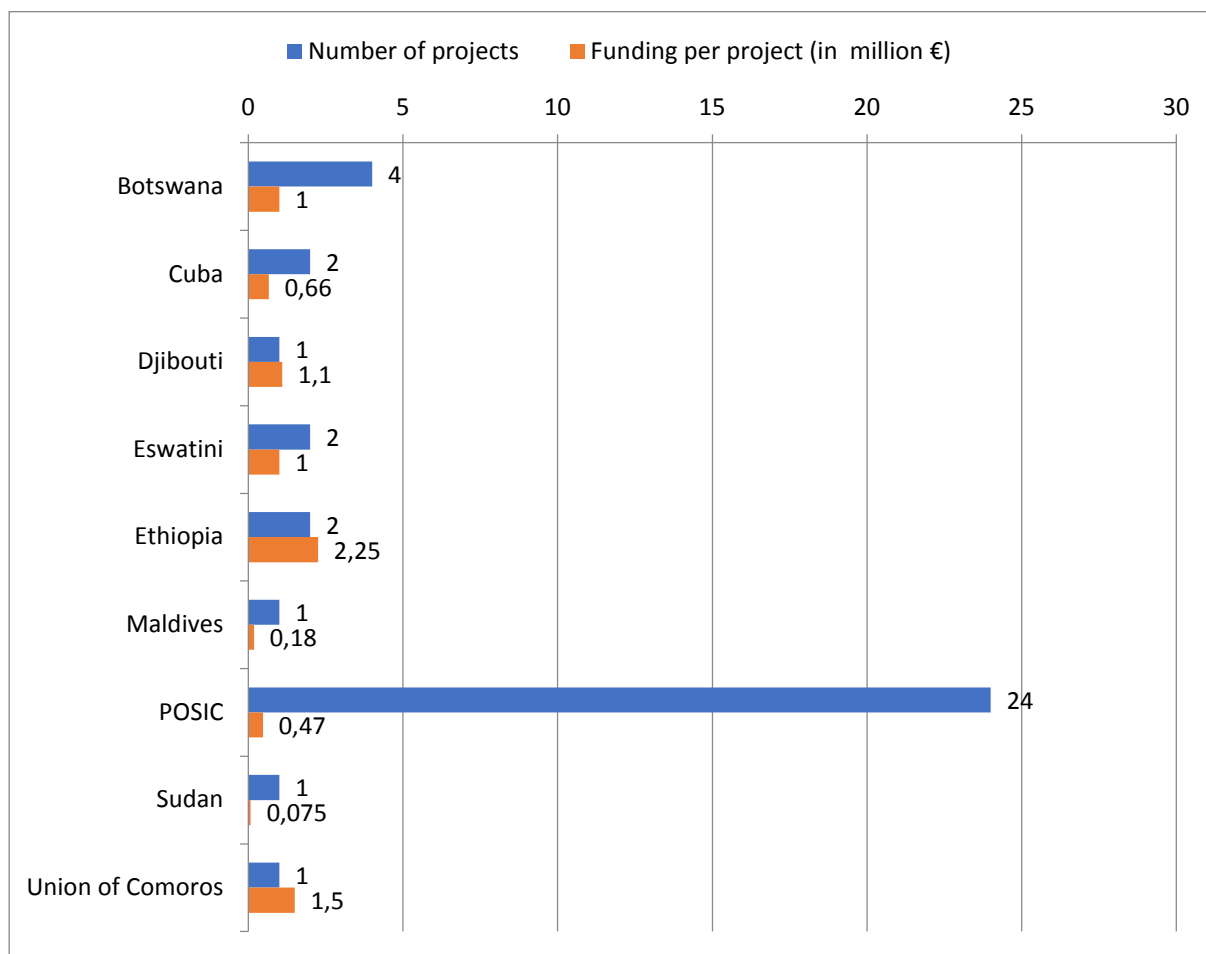


Figure 16: Number of projects & funding per projects for “Italy Group”

Valid cases: 9 countries; missing cases: 2 countries missing

8.2.4 Duration of funded projects

The duration of funded projects was asked in Q1.6. The following Figure 6 shows the varying shares of programmes with different project funding duration. Unfortunately, there only data available for about one third of the programmes identified: from 13 programmes in 9 countries (see Figure 17).

Almost one third of the programmes last for 4 or 6 years. 2 years programmes are mentioned for almost one quarter of the programmes. Other duration is not common. Long project duration has been registered in Taiwan, India, Colombia, Ecuador and Peru.

This distribution is quite different of the one identified for European programmes. In the European context the highest share was run by projects with duration from 1,1 to 3 years.

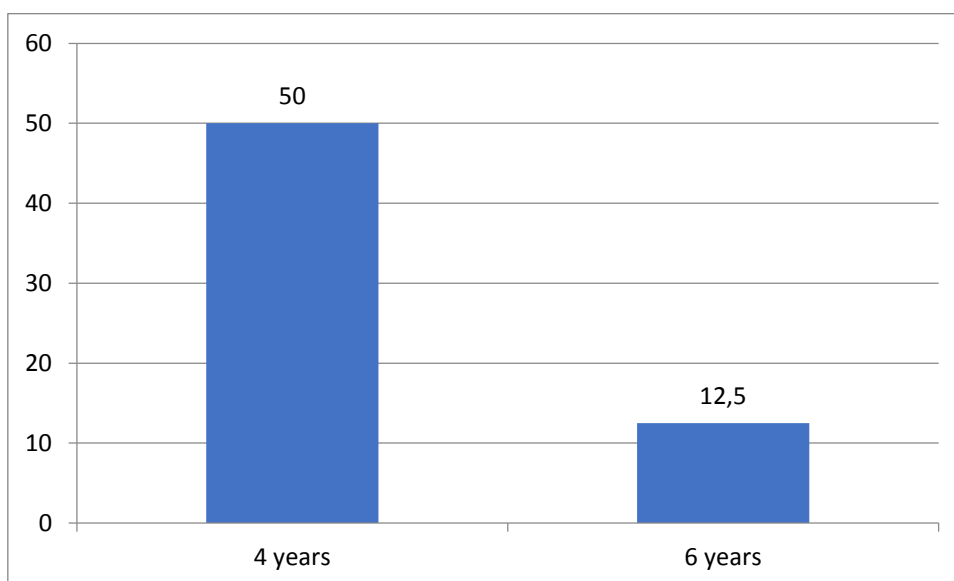


Figure 17: Duration of project funding (in per cent of programmes)

Valid cases: 13 programmes; missing cases: 22 programmes missing

8.2.5 Duration of programmes

Figure 18 depicts the duration of the programmes specified by the respondents in Q1.7 of the questionnaire. Data are available for only 8 programmes in 5 countries.

Half of the programmes described have duration of 4 years, one quarter of 12 years, one eighth each for 6 and 8 years.

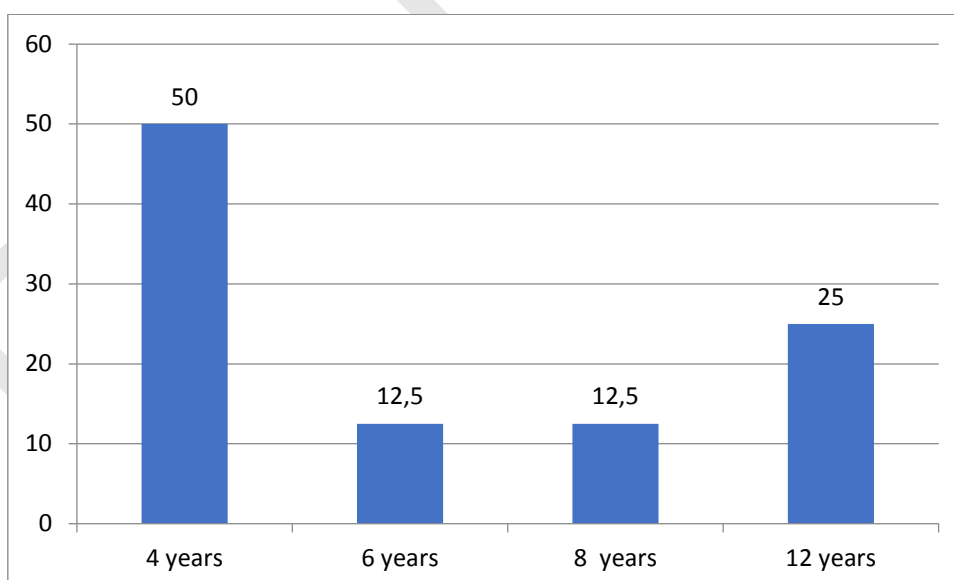


Figure 18: Duration of funding programmes

Valid cases: 8 programmes; missing cases: 27 programmes missing

8.2.6 Examples of funding schemes, initiatives and funded projects

In order to better illustrate the different schemes, initiatives and funded projects, respondents were asked to provide examples (Q1.8). Based on the results, the following box gives an overview.

Box 1 Examples of funding schemes and of funded projects

In Federal State of South **Australia**, the programme “Recycling Infrastructure Grants” implemented by Green Industries SA has supported round 80 existing or new recycling infrastructures.

In **Taiwan** the Planning of the Energy-Resources Circular Style Water Reclamation Center has been supported by the national programme “Integration energy and resources”.

In the **USA** the private “Closed Loop Fund” has founded different cities in projects aiming to increase recycling rates and build circular supply chains.

The national programme “Integrated Processing Development Scheme” has financed a Common effluent treatment plant for textile cluster in Jaipur (**India**).

In recent years the Ministry of Science and Technology in the **PR China** has funded National Key Research Projects on Solid Waste Resourcization.

The **South African** Green Fund supported Research into a policy framework to promote sustainable innovation and capacity building projects.

The programme “Sustainable Recycling Industries in **Colombia**” supported projects like “Technical assistance and training on the recovery of metals from waste”.

The project “Technical assistance and training on the sustainable recovery of metals from waste while sound management of POPs (Persistent organic pollutants)” took place in **Ecuador** in the frame of UNIDO programme “Solving the e-waste problem in Latin America”.

The German programme owner GIZ mbH funded “The Sustainable Urban Mobility in Secondary Cities in **Peru**” dealing with “Technical assistance and training on sustainable transport systems”.

An example for cooperation between Italy and a developing country in the frame of the programme “Cooperation in the field of climate change vulnerability, risk assessment, adaptation and mitigation” is the project “Irrigation for a resilient and sustainable agriculture” implemented in **Vanuatu**.

8.2.7 Resource flows addressed

The multiple-choice question (Q1.9) concerning the resource flows addressed by the programmes identified in 30 countries received 124 answers (see Figure 19).

“Waste” (76,5%) and “water” (64,7%) are the most addressed resources.

“Chemicals” and “metals” play also a role in around 40% of the programmes. The next group of resources include “plastic”, “minerals”, “biomass”, “food” and “others” with a share around 30%.

“Construction & demolition”, one of the most important topics in the European context, practically does not exist in this international survey (share of 5,9%).

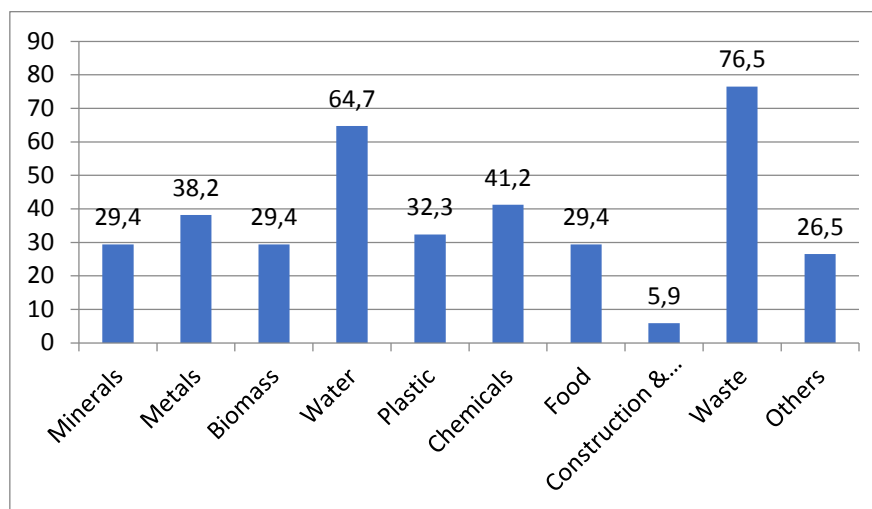


Figure 19: Shares of programmes covering different resource flow (in per cent)

Valid cases: 34 programmes; missing cases: 1 programme missing

8.2.8 Product life cycle phases addressed

The different phases of the product life cycle were retrieved in Q1.10. Here also multiple indications were allowed, so that respondents could choose any relevant response categories from Product design, Manufacture, Distribution and Use, Second life (repair, refurbish, remanufacture), and End-of-life (collection, recycle, recovery).

Figure 4 shows the frequency of the product life cycle phases that were addressed by the programmes covered in the survey.

70,6% of all programmes have a focus on the “End-of-life” phase. “Manufacture” and “Second life” are indicated in about 60% of all programmes. “Distribution & use” and “Product design” are following with shares of 47 and 38,2% (See Figure 20).

In comparison with the European benchmark (Figure 19 of D1.2) in both cases the “End-of-life” phase is predominant. “Product design” and “distribution & use” are weaker in the international context.

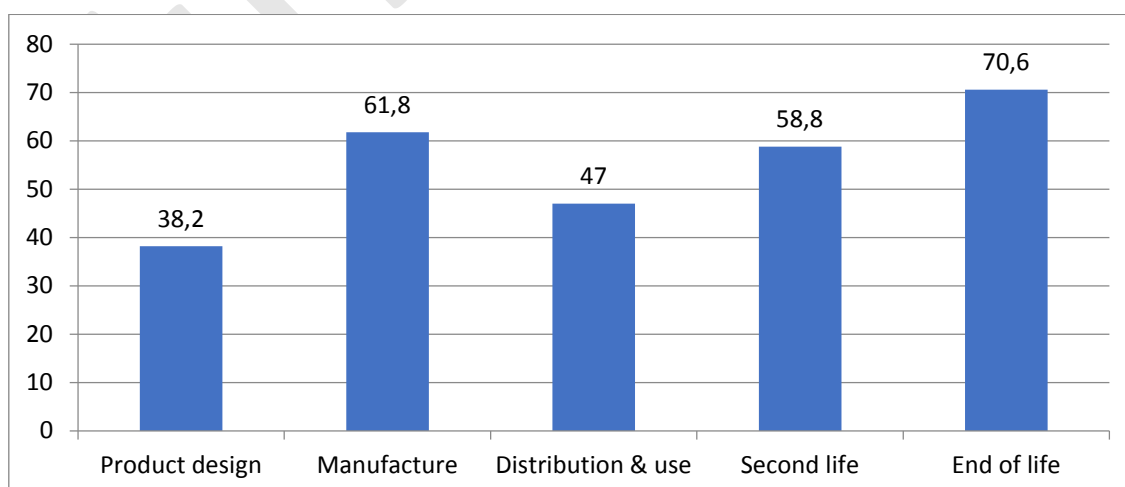


Figure 20: Shares of programmes covering different product life cycle phases (in per cent)

Valid cases: 34 programmes; missing cases: 1 programme

8.2.9 Major types of funded activity

Q1.11 addressed the major types of the funded activities. Respondents were asked to indicate the most relevant ones out of a selection of seven categories which were:

- Science & basic research (often R projects),
- Technology and process optimisation (often D&I projects, transfers),
- Business models & start up support (including coaching, consultancy),
- Policy support (such as policy implementation or recommendation),
- Social & behaviour (e.g. awareness raising, consumer behaviour),
- Education, training & qualification (e.g. students trainees), and
- Coordination (e.g. clusters, networks, platforms).

Figure 21 shows that by far the largest share of programmes (57.1%) addresses the funding activity “technology and process optimisation”. A certain share of programmes of funding projects is related to the activities “policy support” (25,7%) and “education, training and qualification” (20,0%). All other activities have a low share: 8,6% for “business model and start-up support”, “social and behaviour” and “coordination”, only 5,7% for “science and basic research”.

In comparison with the European benchmark (Figure 7 of D1.2) the most common activity is “technology and process optimisation” in both cases. But everything else is different in European and international context. International programmes are funding much oftener the activities “policy support” and “education, training and qualification”. On the other hand, “business model and start-up support” and especially “science and basic research” have much lower share than in the European context.

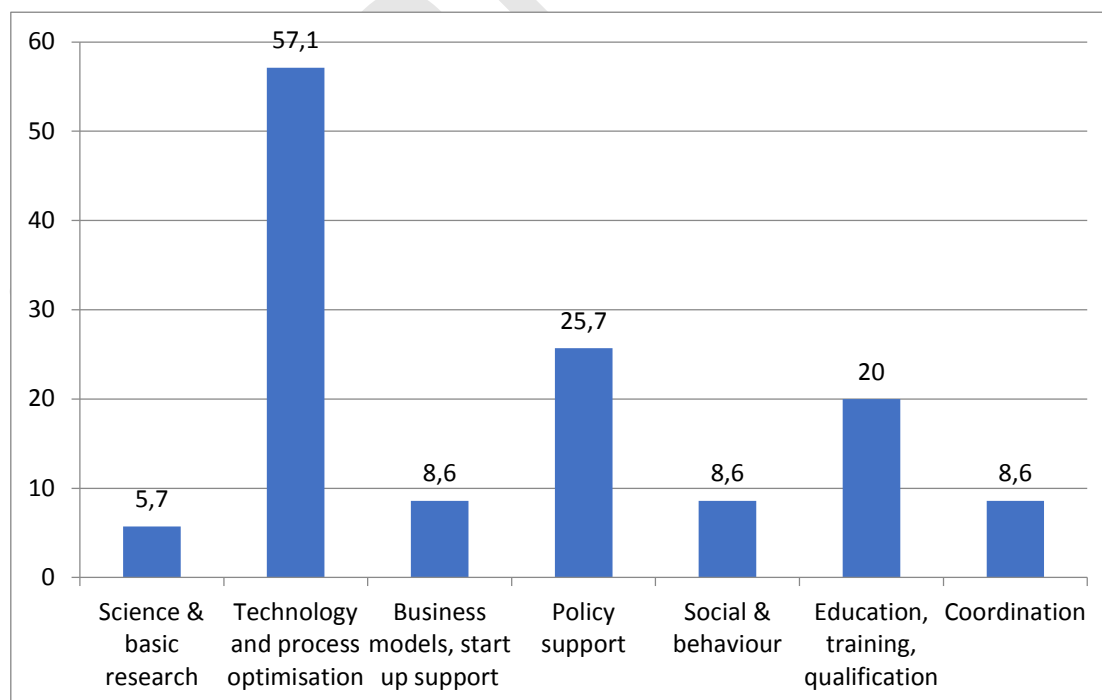


Figure 21: Focus on funding, by activities (in per cent of programmes)

Valid cases: 35 programmes; missing cases: 0 programme

Another way of visualisation accentuates which countries have a focus on which funding type (see Table 3): For example, technology & process optimisation was reported as the main focus on Business models & start up support. Several countries appear to have a balanced portfolio of programme types. It must be stressed however that the selection process which programmes were identified and considered as “worth reporting” was conducted by the survey respondents who represented the country experts in the project consortium.

8.2.10 Economic sectors addressed

Question 1.12 put a focus on the economic sectors addressed by the funding programmes. It was recommended to use NACE sectors in case the programmes had a sectorial focus. Therefore, multiple responses were possible.

Figure 22 depicts the shares of programmes addressing different economic sectors.

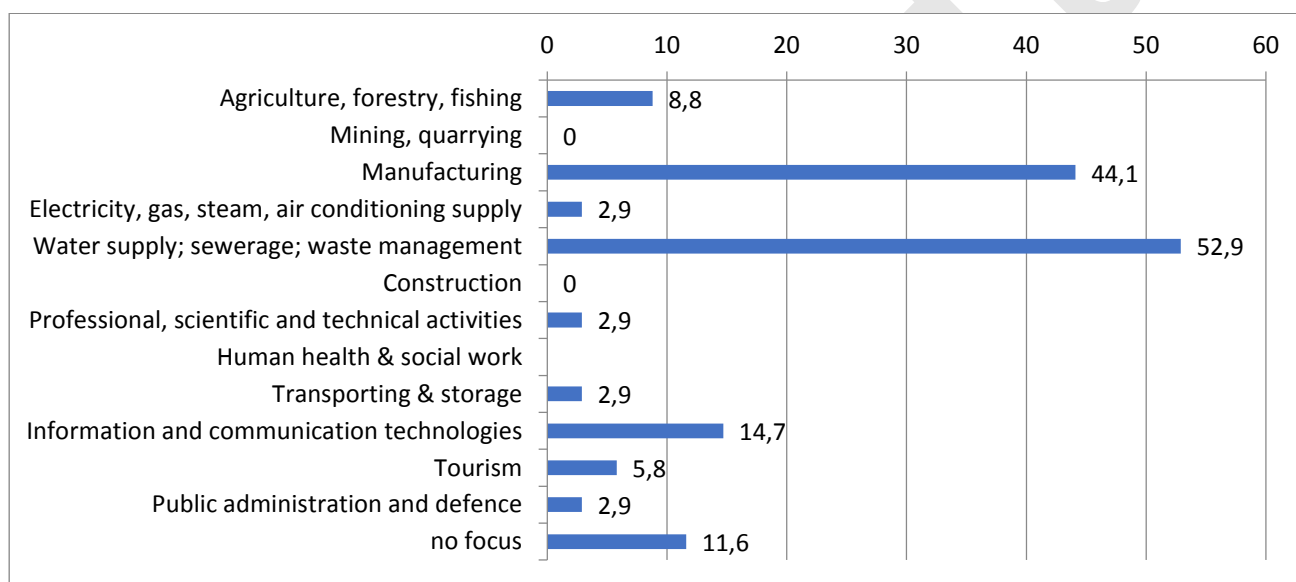


Figure 22: Shares of programmes covering different industrial sectors (in per cent)

Valid cases: 34 programmes; missing cases: 1 programme

The results depicted in the figure above show that the sectors most frequently addressed by the described programmes (44,1%) are the “water supply, sewerage and waste management” followed by “manufacturing” sector.

Only three further sectors have relevant shares of programmes mention: “Information and communication technologies” (14,7%), “agriculture, forestry and fishing” (8,8%) and “Tourism” (5,8%).

Other sectors are addressed by considerably lower shares of 0-3% of the programmes.

In comparison with European benchmark (Figure 8 of D1.2) the economic sectors “water and waste management” as well as “manufacturing” clearly predominate. A more integrative and forward-thinking R&I approach based on trans-sectors cooperation is needed.

8.2.11 Level of technological readiness

In Q1.13 respondents were asked to specify the technology readiness level in case the funding programme described had a focus on technology innovation. This term is used in order to assess the maturity of a technology towards full economic operation and is therefore useful for governments or funding bodies to define eligibility criteria. For the purpose of this survey, it had to be distinguished between “Basic research” (TRL 1-2), “Lab Demonstration” (TRL 3-4), “Field pilot” (TRL 5-6), “Market introduction” (TRL 7-8), and “Scaling” (TRL 9).

More than half of the programmes analysed address the highest level of technological readiness: “Scaling” (TRL 9). The second most common level is “Field pilot” (TRL 5-6) with 28,6 % of all programmes. With a share of 21,4 % “Market introduction” (TRL 7-8) is also quite often addressed while both lowest levels practically do not occur (see Figure 23).

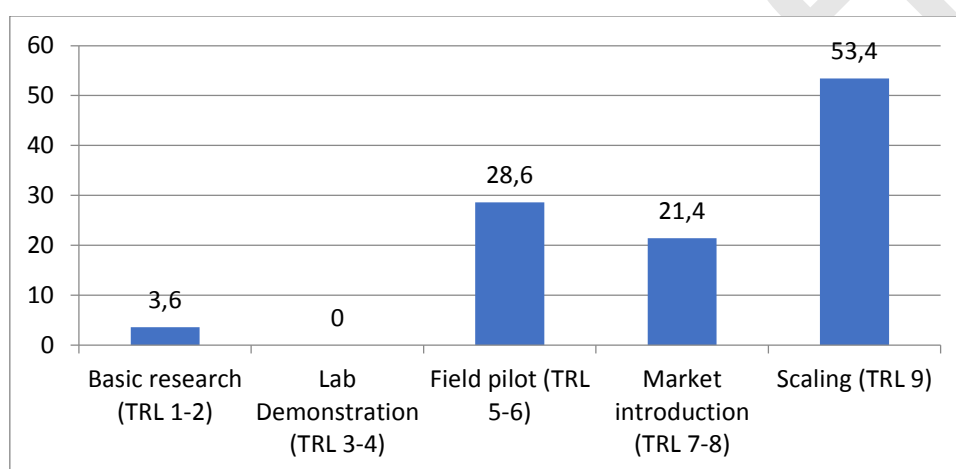


Figure 23: Technology Readiness Level of funding programmes (in per cent)

Valid cases: 28 programmes; missing cases: 7 programmes

The distribution of TRL in international context seems to be completely different than in European one (see D1.2, Figure 9). Scaling is much more important in the international programmes analysed. All other TRL are much higher in the European context.

8.2.12 Beneficiary types

The survey contained an open question on the types of programme beneficiaries. The given survey responses have been categorized on the basis defined by the authors of the CICERONE report on European benchmark (D1.2, Table 5). The result is depicted in Table 17.

Table 17: Categorization of survey responses on beneficiaries

Survey responses on programme beneficiaries	Categorization
Commercial/state enterprises, SMEs, industry, large industry, business companies and cooperatives, consortia of enterprises, self-employed (self-governing), legal persons, private-public bodies, public corporations	Companies
Public/private universities and technical colleges, public/private research (incl. knowledge dissemination) institutions, research, development and innovation, institution, academia	Research institutions
Municipal associations, regional and local authorities, state organisations, public institutions	Municipalities
Public sector, environmental agencies, central administration, entities of	Public institutions

territorial self-government, policy makers	
Non-profit organisation, non-governmental organisations, non-economic organisations, contributory organisations, civil society organisations, environmental foundations, social and solidarity economy structures	Non-profit organizations (NPOs)
Society, consumers, wider population,	Other

Figure 24 depicts the shares of the programmes covered in the survey which address the different beneficiary types.

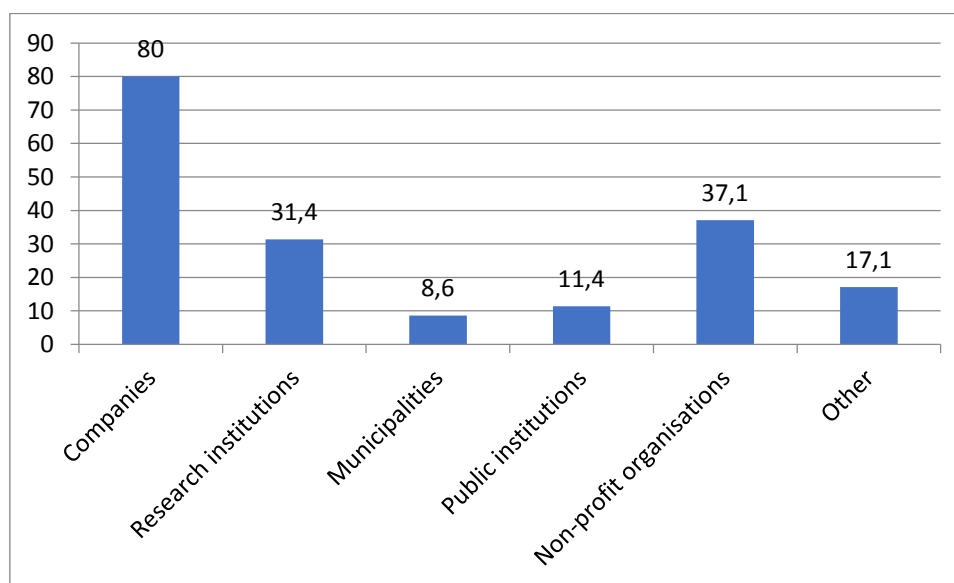


Figure 24: Shares of beneficiaries of funding programmes (in per cent)

Valid cases: 35 programmes; missing cases: 0 programme

“Companies” belong to the eligible beneficiaries of 80% of all programmes. The second large group of beneficiaries includes “Non-profit organisations” and “Research institutions” with both a share around one third of the programmes. “Public institutions” and “Municipalities” reach together 20%.

In comparison with the European benchmark (D1.2, Figure 10) “Companies”, “Municipalities” and “Public institutions” have similar shares. The “Non-profit organisations” have a much higher share while “Research institutions” are less common. Most of the beneficiaries included in the category “Other” are the “Society altogether” and the “Consumers”. Other beneficiaries identified in the European benchmark are not addressed (e.g. “Education”, “Business consulting”).

8.2.13 Key performance indicators, targets and actual developments

For both public funders and private investors Key performance indicators are of great importance. For this reason, the survey asked in Q1.15 whether and which of the identified CE programmes contained Key Performance Indicators (KPIs), such as “reduced primary raw materials input” or “increased secondary raw material input”, or others. In addition, potential targets and the actuals were also queried.

A closer look at the responses to this question on Key Performance Indicators revealed that the questionnaires were often completed with information on qualitative objectives to be achieved by the different funding programmes. In order to get an overview which objectives are essentially

pursued by the programmes, they were grouped into three different categories: ecological, economic, and societal targets. A single programme may address two or three targets.

- **Ecological targets** are covering waste reduction, increasing of reuse, remanufacturing and recycling, reducing emissions, climate relevant gases, energy and resources consumption as well as responsible production.
- **Economic targets** addressing innovative technologies, improved products and processes, increased revenues, new patents, and licensing agreements, strengthening the production and productivity and supporting start-ups.
- **Societal targets** including job creation, participation and good governance, poverty relief, education, increasing knowledge and knowledge transfer, societal innovation and improving the quality of life.

There is a clear ranking from “ecological target”, indicated in two third of all programmes, “economic target” (60%) and finally “societal target” with a share of 44% (see Figure 25).

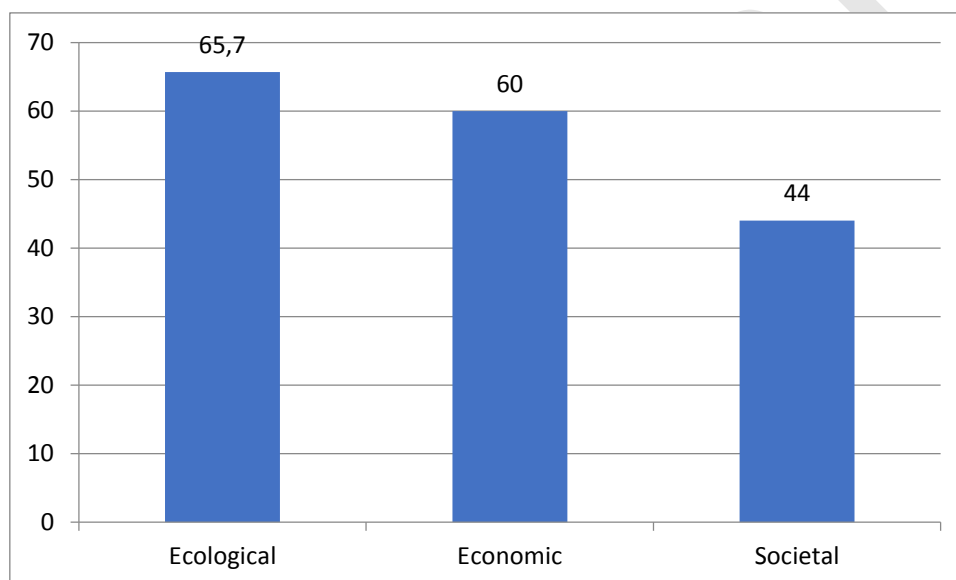


Figure 25: Key performance indicators of funding programmes (in per cent)

Valid cases: 35 programmes; missing cases: 0 programmes

As shown in Table 18, “ecological targets” are combined with “economic targets” for 16 programmes from 10 countries. There is a unique case of a programme with both ecologic and societal targets: this is the Indian Program “Swachh Bharat Mission” promoting sustainable sanitation, positive gender impact and social inclusion in rural areas.

The programmes identified in South Africa are another exception as all three of them have no ecological target but both economic and societal targets, the main target being job creation. The last exception is given by the large programme “Special Funds for Promoting Circular Economy” from People’s Republic of China, a programme addressing all three kinds of targets. In the strict sense it may be considered as the unique real CE funding programme or at least as a model.

Table 18: Targets grouped country-by-country

	Programme 1	Programme 2	Programme 3	Programme 4	Programme 5
Australia	Ecological	Societal	Economic		
Japan	Ecological	Societal			
	Economic				
Korea	Ecological	Ecological	Ecological	Ecological	Economic
			Economic	Economic	
Taiwan	Societal	Ecological			
		Economic			
USA	Ecological	Ecological	Economic	Societal	
	Economic	Economic			
India	Ecological	Ecological	Ecological	Ecological	Ecological
		Economic	Societal	Economic	Economic
PR China	Ecological	Ecological	Ecological		
	Economic	Economic	Economic		
	Societal				
South Africa	Economic	Economic	Economic		
	Societal	Societal	Societal		
Colombia	Ecological				
	Economic				
Ecuador	Ecological	Societal	Ecological		
			Economic		
Peru	Ecological	Ecological	Ecological		
	Economic				
"Italy Group"*	Ecological				
	Economic				

* Botswana, Cuba, Djibouti, Eswatini, Ethiopia, Iran, Lesotho, Maldives, Pacific Ocean Small Insular Countries, Sudan and Union of Comoros.

8.2.14 Collaboration between funding programmes and indicated areas on joint funding

No collaboration between funding programmes has been identified.

Two international programmes funded by the European Commission cooperate with the United Nations and national partners: SWITCH ASIA and SWITCH Africa Green.

The SWITCH-ASIA II Program was launched in 2007 with funding from the **European Union**, the SWITCH-Asia I Program achieved more than a decade of progress on sustainable consumption and production across Asia, e.g. in **India**. This is enabled by the joint efforts of the Sustainable Consumption and Production Facility (implemented by GIZ, IGES and Adelphi), the Regional Policy Advocacy Component (implemented by UN Environment), the European Union Delegations and grant recipients.

A similar initiative, SWITCH Africa Green has for main objective to support six countries in Africa, e.g. in **South Africa**, to achieve sustainable development by engaging in transition towards an inclusive green economy, based on sustainable consumption and production patterns, while generating growth, creating decent jobs and reducing poverty. The objective will be achieved through support to private sector led inclusive green growth. SWITCH Africa Green cooperates with UN Environment, United Nations Development Program and United Nations Office for Project Services.

8.3 SURVEY RESULTS ON LEGAL MECHANISMS AND TECHNOLOGY AND BUSINESS FIELD DEVELOPMENT IN EXTRA EUROPEAN COUNTRIES

8.3.1 Recent legislation for CE

Circular economy is the aim of numerous recent legislations around the world. Some examples identified during the survey are listed in Box 3.

Box 3: Recent legislation for Circular Economy

In **Australia** the Parliament discussed 2018 about improving the “National Waste Policy: Less Waste, More Resources” (2009). The Environment and Communications Legislation Committee recommended: “the Australian Government must act urgently to transition away from a linear economy to a circular economy which priorities the collection, recovery and re-use of products, including within Australia. This transition must include a suite of regulatory and policy changes aimed at influencing behavior, as well as investments in infrastructure and technology.”

As example at the Federal State level the “New South Wales Circular Economy Policy” was adopted in 2019.

In **Japan**, the 4th Fundamental Plan for Establishing a “Sound Material-Cycle Society” was approved by the Cabinet on June 19th, 2018, indicating measures to be implemented in a strategic manner. The Plan is formulated based on the Basic Act on Establishing a Sound Material-Cycle and sets a mid- to long-term direction for the establishment of a sound material-cycle society in Japan.

In **Taiwan** the Act Resource Recycling Act is supposed to integrate Waste Disposal Act and Resource Recycling Act. It is definitely critical to push circular economy. Taiwan Executive Yuan had already passed the draft on July 25, 2013. However, it is still difficult to be passed by Legislature due to the confused social condition. In 2017, the Forward-looking Infrastructure Development Program was launched, in which green energy infrastructure and water environments are related to circular economy issue.

In **India** there are several new legislation supporting the circular economy: e.g. the “Extended Producer Responsibility Law on e-waste”, adopted in 2016 by the Ministry of Environment, Forest and Climate Change, the “Use of RDF regulated in industrial units under the Solid Waste Management Rules”, also 2016. Further examples come from the Federal States e.g. the “Policy on water reuse” in Maharashtra, with the objective of reusing the treated wastewater to cool thermal power plants, serve industrial estates, and other non-potable purposes.

The **People’s Republic of China**'s 13th Five-Year Plan (2016-2020) was legislated on March 15, 2016. The key goals of the 13th Five-Year Plan include promoting circular production to establish a circular economy at all levels in society, creating a circular development system with new resource strategies, reducing waste and consumption, increasing resource efficiency, and supporting green initiatives.

On January 21, 2019 the State Council of China issued the Work Plan for the Pilot Programme of “Zero Waste Cities”. Construction of the pilot zero-waste city project is of great significance to promote and deepen comprehensive reform of urban solid waste management, and an important measure to realize an ecological civilization and build a beautiful China. It aims to be a replicable programme that realizes the nation's zero-waste target and include following points:

- Ten cities will be selected as pilots, with a comprehensive consideration of region, development level and local industry. By 2020 they are expected to have established a comprehensive management system for waste and to be demonstration models for zero-waste cities,
- Establish a national consistent statistical system for solid waste,
- Promote green mining (key sectors: coal, nonferrous metal, gold, metallurgy, chemicals, non-metallic mining), green supply chain and solid waste recycling (key sectors: battery, electronics, automobile).

In November 2017, Nigeria, Rwanda, **South Africa** and partners, including the World Economy Forum and the Global Environment Facility, launched the “African Circular Economy Alliance” to spur the continent’s transformation to a circular economy, which delivers economic growth, jobs and positive environmental outcomes.

A very important development in **Colombia** is the existence since 2018 of the “National Strategy on Circular Economy” which serves as the basis for improvements in the next years. As of now, most CE related approaches in Colombia refer to zero waste and extended producer responsibility (EPR) (incl. the EPR law) and the setup of take-back systems and recycling facilities for different types of waste.

In **Ecuador** the secondary normative “Institutional Framework for Environmental Incentives” established 2018 economic incentives to public or private enterprises that develop distinguished environmental initiatives among others, related to the promotion of circular economy.

Another example from **Ecuador** is the 2018 “Ordinance to regulate single-use plastics” in Guayaquil. The objective of this secondary law is to adopt measures to regulate the production, commercialization and distribution of single-use plastics in Guayaquil. It also aims to promote the reduction of the consumption of single-use plastics and the development of a circular economy through the enhancement of materials coming from waste and others of vegetal origin and biodegradable.

In **Peru** the Waste regulation (law 1278 from 2017) considering extended producer responsibility principle. It promotes that manufacturers, importers, distributors and marketers manufacture or use products or packaging with criteria of eco-efficiency that minimize the generation of waste and / or facilitate its recovery, taking advantage of resources in a sustainable manner and reducing at least its impact on the environment. They are also responsible for participating in the life cycle stages.

The Congress of **Peru** approved on Wednesday, December 5, 2018, the Plastics Law, that gradually bans the use of plastic bags and packaging of this polluting material in order to reduce its use in a first year by 35% (end of 2019) and fully bans these materials 2021. A tax for the distribution of plastic bags was introduced.

Regarding circularity concept in **Iran**, recycling is one of most explored field by private sector, as demonstrated by Association of Iran Recycling Industries founded already in 2008 and supported the delivery of Iran Waste Management Act.

8.3.2 Country-specific trends in technology development

In order to retrieve some insights regarding the spectrum of technology developments, the country respondents were conclusively asked in Q4.1 to provide information on country-specific trends in CE innovation, for example, waste separation technologies, 3D print, etc.

An overview of CE relevant trends in the technological development of twenty extra European countries is provided in the following Table 19. The technology trends cover a wide range and vary from water and waste management and communication technologies to sustainable tourism and artificial intelligence.

Table 19: Country-specific trends in technology development

Country	Country-specific trends in technology development
Australia	Waste management, new mining technologies
Japan	Waste separation, AI, Nanotechnology, Biotechnology
South Korea	Waste separation, electro mobility, fossil-based energy, GHG reduction
Taiwan	AI, Nanotechnology, Biotechnology
USA	Many different trends in technology development, e.g.: electric cars, solar panels, powerwalls by TESLA, many projects focussing on materials management with innovative industrial strategies (e.g.: Caterpillar - Cat Reman, Lehigh Technologies (Michelin Tires), BioCollection)
India	Waste-to-energy; WEEE recycling; Sewage Treatment Plants; Zero Liquid Discharge, e-mobility, digitalization
PR China	Should accelerate the innovation of key technologies for the field of reduction, reuse & reproducing, waste resource utilization, processes and technologies in the fields of reduction, reuse and remanufacturing, waste resource utilization, industrial symbiosis and links. Taking waste area for example, some specific technology development demands: <ul style="list-style-type: none"> * Phase Reconstruction and Transformation of Bulk Aluminosilicate Inorganic Solid Waste * Organic solid waste directed biotransformation and control * Technologies for solid waste reduction and near-zero emission in key industries * Organic solid waste full-component clean conversion and new technology for safe utilization * New technology for rapid identification and detection of hazardous components of hazardous wastes * Urban solid waste big data and life cycle management and control technology * Phosphorus, sulphur and chlorine solid waste source reduction and recycling integration technology * Community garbage intelligent classification and clean collection technology and equipment * Intelligent sorting and upgrading utilization technology for urban construction waste * Retired lithium battery material component clean recycling technology
South Africa	Waste recycling infrastructures, renewable energy plants, clean energy projects, water projects
Colombia	Replacements of plastic packaging through biodegradable/sustainable packaging or other options with lower footprint. Biocomposting at industrial levels are urgently required research as well on this area
Ecuador	Research on waste technologies are dominating the list of research activities
Peru	Replacements of plastic packaging through biodegradable/sustainable packaging or other options with lower footprint. Biocomposting at industrial levels are urgently required research as well on this area
Botswana	Water resource management
Cuba	Waste management, sustainable tourism, food
Djibouti	Sustainable agriculture, water management
Eswatini	Meteo alert
Iran	Water management, waste management
Lesotho	Water management
POSIC	Water management, sustainable agriculture
Sudan	Water management
Union of Comoros	Water management, waste management

8.3.3 Country-specific trends in circular economy business field development

Like the question above, Q4.2 asked the respondents to spotlight country-specific trends in CE business fields.

The results of eleven extra European countries, which provided information on this aspect, are shown in Table 20. The business fields stressed address a range of sectors such as repair shops, digitalisation and education.

Table 20: Country-specific trends in circular economy business field development

Country	Country-specific trends in circular economy business field development
Australia	Technologies and infrastructures mainly, but education and training play a relevant role. Renewable energy is indicating as transition towards circular economy factor
Japan	Biotechnology, Sharing Economy, Product Servitization/Virtualization, Internet of Things
South Korea	Alternative energy, fuel economy, energy recovery, Waste in the Automotive industry
Taiwan	Sharing Economy, Product Servitization/Virtualization, Internet of Things
USA	22.1% of the circular economy initiatives listed in the US CE Study of 2018 focus on packaging, 19.8% on materials management, 17.5% on manufacturing, and 16.6% on apparel. Waste as a resource is the most common intervention point with 39% of initiatives incorporating this approach into their business model.
India	Refuse-derived fuel usage in industrial units; compulsory purchase of power produced from waste-to-energy plants; Reuse of treated wastewater; recycling of plastic bottles
PR China	Third-party outsourcing service for industrial waste; Resource recycling, "Internet +" renewable resource recycling and remanufacturing technology service
South Africa	Waste re-use (e.g. Rambrick), e-waste recycling, Product design
Colombia	Repair shops are booming in the different cities of Colombia. This is creating jobs for people with technical skills (no need for a university degree) having done an apprenticeship. Professionalization of this work (e.g. Recycling experts are needed)
Ecuador	Cities or islands initiatives are advancing, e.g. in Quito, Guayaquil and Galapagos. Also, refurbishment initiatives are an important activity
Peru	Repair shops are booming in the different cities of Peru. This is creating jobs for people with technical skills (no need for a university degree) having done an apprenticeship

8.4 ACTORS

Examples of actors supporting the Circular Economy in the countries analysed are given in Table 23 in Annex.

For most countries partners have been identified in the three groups considered: Networks, clusters and associations; Industry and others. The third category "others" regroups academia, administration, civil society and other kind of stakeholders not considered in the first two categories.

8.5 LEVEL OF ALIGNMENT OF THE ANALYSED COUNTRIES

The 22 countries analysed cover a large spectrum of level of alignment with Circular Economy according to European Definition (see Figure 26). Four developing countries have a low level from 1.

South Africa and Peru have been estimated a level of 1,5. Most countries analysed (13) have a level of 2 although they have very different background and track records. Among these countries are industrial, BRICS and developing countries.

According to this very simple ranking the three countries with the highest level of alignment are all in Asia: Japan, Taiwan and the People's Republic of China.

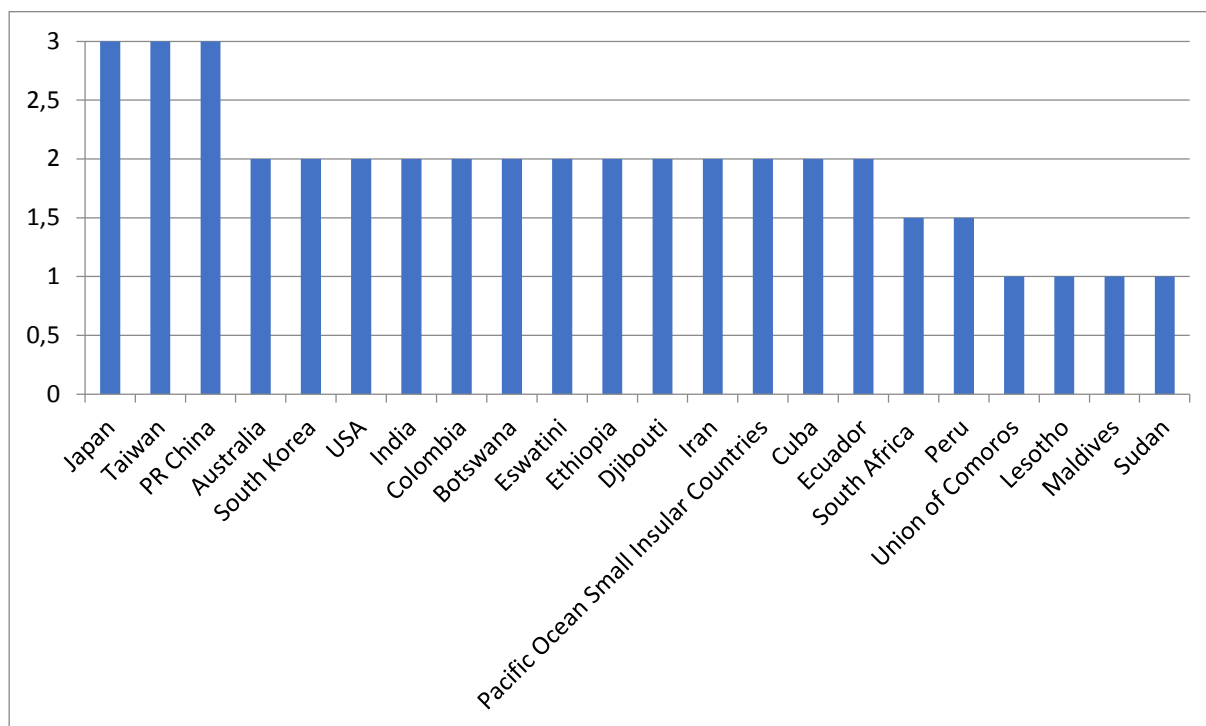


Figure 26: Level of alignment of analysed countries

(Level: 0 to 3 according to 1.3, Series sequence within a category is random)

9 GENERAL CONCLUSION

The analyse of the role of some selected international organisations has shown that these have a close cooperation with the European Union under participation of policy makers, industry, academia, civil society and other stakeholders.

Looking at the programme owners in the EU cooperating with extra European countries in the field of Circular Economy it seems that more could be done to implement the ambitious objectives agreed among policy makers in international organisations.

Based on the assessment of 35 R&I programmes identified in 30 countries, the results can be summarised as follows:

At present, the R&I programmes for CE in extra European countries overwhelmingly consist of national programmes with a volume of less than 1 million and duration of 4 years. The focus is predominantly on the resources flows “waste”, “water” and “chemicals”, and the most frequently addressed product life cycle phases are “end-of-life phase”, “manufacture” and “second life”.

The major type of funding is predominantly addressed to technology and process optimisation and the most frequently beneficiary types are “companies” from the “water & waste sector” and “manufacturing” sectors. Regarding the Technology Readiness Levels (TRL), the programmes are mostly addressing the highest level “scaling” (TLR 9) or referred to “field pilots” (TLR 5-6).

Objectives of organisations and countries analysed are mainly “economic” and “societal” and while key performance indicators show a focus on “ecological” targets. There is no clear explanation for this funding.

No collaboration between funding programmes has been identified in the 30 extra European countries considered.

Numerous recent legislations on Circular Economy have occurred around the world. In some cases, this was the consequence of a rewording or focussing of former strategies e.g. for Green growth, Green economy or Resource efficiency. In other cases, there was a widening of the topic addressed mainly waste and water management to the broader circular approach. This observation has been made for different continents and different kind of countries (industrial, developing or BRICS countries).

The country-specific trends in technology development identified in industrial and BRICS countries are very similar to those described for Europe in CICERONE report D1.2 while the focus in most developing countries is clearly on water and waste management. The same remark can be made for the country-specific trends in circular business fields with a high interest in repair shops in the three Latin American countries.

Actors like networks, clusters and associations, industry, academia, administration, civil society have been identified in most countries. The first category “networks, clusters and associations” brings stakeholders along the life cycle together and seem to play a very significant role on all continents.

The level of alignment with CE European definition seems to be very high or high in all industrial and BRICS countries apart from South Africa. More than half of the developing countries considered have a similarly high level of alignment.

In comparison with the results of the European Benchmark (CICERONE report D1.2) following similarities and differences have been identified:

Similarities:

- “National funding programmes” are predominating
- “Waste” is the most common resource addressed
- The “End-of-life phase” is the most common
- The major type of funding is “Technology and process optimisation”
- The most frequently beneficiary are “Companies” from “Manufacturing”, “Water” and “Waste” sectors
- The Technology Readiness Levels “Fields pilots” (TRL 5-6) and “Market introduction” (TRL 7-8) are commonly addressed
- “Ecologic” and “Economic” targets are very common

Differences in international context versus European context:

- The budget per project is lower
- The project duration is longer
- “Water” and “chemicals” are also addressed very often
- Other product life cycle phases are well addressed: “Manufacture” and “Second life”
- “Non-profit organisations” are much more often beneficiaries
- The most common Technology Readiness Level is much higher: Scaling (TRL 9)
- “Societal” targets are more common

In chapter 7, a report reviewing the technology trends and market conditions in CE relevant secondary materials supply sectors was prepared by GKZ as an attachment to D1.3. The report aims at highlighting most challenging technology developments in the secondary raw materials (RM)

economy outside of Europe that influence and impact emerging technology sectors in Europe. The commodities studied in this report include cobalt, nickel, tin, rare earth elements (REE) and gallium which are crucial for the emerging technologies, either as materials used in producing the emerging technologies or as carrier materials which produce CRM as by-products.

Although each commodities have its specific challenges which are illustrated at the corresponding chapters of the attached report, recurrent themes can be found such as requiring processing technologies which accept diverse material feeds (i.e. primary materials, industrial residues and post-consumer wastes) and which recovers multi-elements as by-products. Hence, a special attention should be paid to the backward integration of the secondary refiners (e.g. Feinhütte Halsbrücke) and forward integration of primary refiners (e.g. Freeport Cobalt) in the EU as this development makes local circular economy possible. At the same time, the capability to process various feed sources may lower the supply risk of the refineries and keep them living within Europe.

Metallurgical infrastructures are indispensable for enabling CE. However, as the latest data shown, while many countries outside of the EU are building new TSL plants in the last 10 years, particularly in Far-East Asia, with only four out of 66 new installations worldwide, the EU investment in this field is not outstanding considering the EU's aim to achieve CE in the near future.

Political or legislative interventions, such as the REACH and specifically lead and copper ban, also challenge producers and recycling companies in the same way. In many cases, production and recycling processes need to be adjusted hard on the limit to economic viability. A principle problem being regarded by many smelting companies is that more and more politics and policies pose production processes and materials supply challenges. The challenges do not always lead to new and more competitive niche inventions, such as the successful replacement of prohibited Cu-Pb alloys with Cu-Si and Cu-Fe alloys, but, for instance, recycling of magnets by shredding and thermal treatment (demagnetisation) resulted in the accumulation of the REE in the slag.

The other framework conditions that the EU should take into consideration are for instance, reducing the knowledge gap by maintaining metallurgical schools and research projects to ensure the deep know-how is transferred to and further developed in the next generation. Another example is to establish CE strategic alliances in international cooperation by fostering the EU's global presence in metallurgical processing and resources.

The analysis of the country data obtained in this report showed that the state of the art in CE regarding capacity resources, legal frame, governmental funding and implementation differs. Taking into account that the data bases is far from being representative, it could be shown that the current state is not linked strictly to the state of economic development of the countries. Japan, China and Taiwan for example have a rather long history in CE and thus have more differentiated funding programmes and legal basis. Countries like the Latin American Counties and Australia have focussed on CE only in the last few years, whereas leading to relatively new structures. In the USA, the CE is mainly driven by the industry and governmental funding is playing a subordinate role. This lead to an own funding structure which is very application-orientated.

Hence, the cooperation of the EU with extra European Countries may on one hand depict knowledge gaps and can show opportunities of constitutional adaptations. On the other hand the cooperation with "CE-Newcomers" may help those to adjust their CE-funding structures in a most effective way.

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11 GLOSSARY

ACEA	African Circular Economy Alliance
ACEN	African Circular Economy Network
BRICS	Brazil, Russia, India, People's Republic of China and South Africa
BRIICS	Brazil, Russia, India, Indonesia, People's Republic of China and South Africa
CE	Circular Economy
CEO	chief executive officer
CGE	Computable General Equilibrium
C2C	Cradle to cradle
COST	Cooperation in the Field of Science and Technology Research
CRM	Critical Raw Material
DEA	National Department of Environment
DRC	Development Research Center of the State Council
DRR	Disaster Risk Reduction
EIB	European Investment Bank
EIP	National Eco-Industrial Park
EPA	Environmental Protection Agency
EPR	Extended producer responsibility
ERA	European Research Area
ERP	Energy recovery programme
ETS	Emission trading system
EU	European Union
G7	Group of 7
G20	Group of 20
GDP	Gross domestic product
GHG	Greenhouse gas
GKZ	Geokompetenzzentrum Freiberg e.V.
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
HDI	Human Development Index
IRP	Integrated Resource Plan
IRP	United Nations International Resource Panel
IS	Industrial Symbiosis
KICOX	Korea Industrial Complex Corporation
KNCP	Korean National Cleaner Production Center
MOOC	Massive Open Online Course
MOST	Ministry of Science and Technology
NCPC	National Cleaner Production Centre
NDRC	National Development and Reform Commission
NEERI	National Environmental Engineering Research Institute
NGO	Non-governmental organization
NIMBY	Not In My Back Yard
NPO	Non-profit organization
NSFC	National Natural Science Foundation of China
OECD	Organisation for Economic Co-operation and Development
PACE	Platform for Accelerating the Circular Economy
PO	Programme Owner
PR	People's Republic
RDI	Research, Development & Innovation
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals

R&D	Research & Development
R&I	Research & Innovation
RECP	Resource efficient and cleaner production
REE	Rare Earth Elements
REP	Resource efficiency programme
RM	Raw Materials
RTP	Recycling technology programme
SDG	Sustainability Development Goals
SME	Small & Medium Enterprises
SMM	Sustainable materials management
SWOT	Strengths, Weaknesses, Opportunities, Threats
TACC	Territorial Approach to Climate Change
TEST	Transfer of Environmentally Sound Technology
TMS	Target management system
TRL	Technology Readiness Level
TSL	Top Submerged Lance
UK	United Kingdom
UNEP	United Nations Environment Program
UN Environment	United Nations Environment Program
UNIDO	United Nations Industrial Development Organization
UNITAR	United Nations Institute for Training and Research
U.S.A./USA	United States of America
VBWF	Volume-based Waste Fee System
WEF	World Economic Forum
WEEE	waste electrical and electronic equipment
WRFA	World Resources Forum Association
WRI	World Resources Institute
WWF	World Wildlife Fund
3Rs	reduce, reuse, recycle

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12 ANNEX

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Table 21: Overview of countries distribution

Countries / Contributors	International organisations	European-International cooperation	Africa	America	Asia	Australia / Oceania	Secondary materials
ENEA	-	-	Botswana, Eswatini, Ethiopia, Djibouti, Lesotho, Sudan, Union of Comoros	Cuba	Islamic Republic of Iran, Maldives	Australia, Pacific Ocean (Kiribati, Micronesia, Palau, Solomon Islands, Tuvalu, Vanuatu)	-
GKZ	-	-	-	-	-	-	X
IVL	-	-	-	-	India, PR China	-	-
JÜLICH	G7/G20, OECD, UN, Australia	X	-	USA	-	-	-
NCKU	-	-	-	-	Coordinator for: Japan, PR China, South Korea, Taiwan	-	-
WRFA	WRFA	-	South Africa	Colombia, Ecuador, Peru	-	-	-

Table 22: QUESTIONNAIRE

General Information	Country / organisation					
	Name of Participant					
	Organisation					
Short explanation to CE in this country (e.g. policy context, structure/system)	Please describe in max. 10 sentence the CE in this country.					
Q1: Funding and initiatives for CE	Please identify max. 5 of the most important CE (framework) funding programmes and other initiatives in your country and analyse them along the following categories.					
Programme	Enter the name of the programme	Enter the name of the programme	Enter the name of the programme	Enter the name of the programme	Enter the name of the programme	Enter the name of the programme
1.1 Programme level (specify country and region, if applicable)	please select	please select	please select	please select	please select	please select
Specify country and region						
1.2 Programme owner and contact person data						
1.3 Programme/company (CE) website						
1.4 Overall budget size (or part of budget allocated to CE) / sales (CE)						
1.5 Number of projects funded (or average funding per project)						
1.6 Duration of funded projects						
1.7 Duration of the programme itself						
1.8 Example projects / example activities, products or services						

1.9 Resource flows (e.g. raw materials, water, plastic, waste, chemicals, food, biomass)	please select	please select	please select	please select	please select	
1.10 Product life cycle phase	tick all that apply					
Product design						
Manufacture						
Distribution and Use						
Second life (repair/ refurbish/ remanufacture)						
End of life (collection/ recycle/ recovery)						
1.11 Major type of funded activity (select the most relevant one for the programme) Science & basic research (often R projects), Technology and process optimisation (often D&I projects, transfers), Business models & start up support (including coaching, consultancy), Policy support (such as policy implementation or recommendation), Social & behaviour (e.g. awareness raising, consumer behaviour), Education, training & qualification (e.g. students trainees), Coordination (e.g. clusters, networks, platforms)	please select	please select	please select	please select	please select	
1.12 Industrial Sectors addressed (use NACE sectors, only relevant if the programme has a sectoral focus) http://ec.europa.eu/competition/mergers/cases/index/nace_all.html						
1.13 If the programme focuses on funding technology innovation select the most relevant innovation stage - Technology readiness level (select one)	please select	please select	please select	please select	please select	
1.14 Beneficiary types (e.g. academia, industry/SME, civil society)						
If you don't think the above classifications (questions 1.9 – 1.14) have described well the programme, please add a brief explanation of the scope and objective of the programme.						

1.15 What are the Key Performance Indicators (KPIs) of the programme? (for example, reduced primary raw materials input, or increased secondary raw material input)							
How are impacts measured?							
What are the targets?							
What are the actuals?							
CICERONE plans to select a few funding programmes for further case studies to identify success factors. If your programme is selected as a case study candidate, would you be interested in participating and in sharing data on the impact of the programme?	please select	please select	please select	please select	please select		
1.16 Please provide joint funding ideas or existing collaborations between funding programmes (if any)							

Q2: Further R&I stakeholders for CE	Please provide (ca. 10-15) further important CE-related public and private stakeholders in your country, incl. one or two keywords to describe his/her role within the R&I context for CE.					
Example-No.	2.1 Priority theme (e.g., raw materials, water, plastic, waste, chemicals, food, biomass and biotechnology)	2.2 Name	2.3 Contact person	2.4 Link/ Website	2.5 Private or public stakeholder	2.6 Specific role in the context (e.g., innovative SMEs, investors and finance institutions, industrial associations, networks, etc.)
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Q3: Recent legislation for CE	Provide 2-3 important national examples of legislative measures in your country (<i>if available</i>) directly triggering research & innovation for CE from 2015 onwards. It is not asked for loosely related strategies or programmes of the years before 2015 but examples of pertinent laws, regulations, guidelines, directives (e.g., plastic ban regulations, CE laws, national roadmaps for CE, etc.) Please specify relevant passages or articles in order to indicate relevance.
Example-No.	Description
1	
2	
3	

Q4: Further R&I priorities for CE	Please identify further R&I priorities of your country with clear CE implications (if available). For example:
4.1 Country-specific trends in technology development (e.g., waste separation technologies, 3D print, electro mobility, etc.)	
4.2 Country-specific trends in circular economy business field development (e.g., ReUse in Flanders, repair shops, etc.)	

Table 23: Indicated data on financial volumes of programmes

Country	Programme (owner)	Original survey data behind annual financial volumes	Issues to which the financial volume is spent
Australia	Recycling Infrastructure Grants	2017-2018: 18 projects, Total funding: AD 671.000, EUROS 416.454	
	Research Attraction and Acceleration Program	920.000 € (budget allocated to activities directly related to CE)	
	Turbo charges battery development (part of Cooperative Research Centres (CRC) Program)	From FY 19/20 to FY 24/25, approx. \$53M in cash and \$82M in kind subject to finalization of funding and participation agreements during 2019	
Taiwan	Integration energy and resources	1.181.972 € (since 2009)	
	Sustainable Materials Management	2.092.122 € (since 2011)	
Japan	4th Fundamental Plan for Establishing a Sound Material-Cycle Society	n/a	
	The Basic Environment Plan	n/a	
South Korea	Target Management System (TMS)	n/a	
	Resource Efficiency Programme (REP)	n/a	
	Energy Recovery Programme (ERP)	n/a	
	Emission Trading System (ETS)	n/a	
USA	Caterpillar - Cat Reman	\$47 billion (€ 42.439.840.040) since 1973 / \$8.5 Billion (€ 7.675.290.220) (sales 2015)	
	Lehigh Technologies (Michelin Tires)	\$88 million (€ 79.461.828) since 2003	
	Closed Loop Fund (Partners)	89,2 million € since 2014	
	Goodwill Industries	\$3.53 billion (€ 3.197.029.467) (revenue 2012)	
India	ENV.2012.6.6-1 - EU-India cooperation in water technology: research and innovation	€ 15.000.000 (2012-2017)	
	Adar Poonawalla Clean City Initiative	INR 100.000.000 (since 2014)	
	Swachh Bharat Mission	INR 620.090.000.000 (€ 8.127.674.652) (2014-2018)	
	Switch Asia - Sustainable Consumption and Production	€ 18.431.439 (since 2009)	
	Integrated Processing Development Scheme	INR 5.000.000.000 (€ 65.536.250) (2012-2017)	

Country	Programme (owner)	Original survey data behind annual financial volumes	Issues to which the financial volume is spent
PR China	Special Funds for Promoting Circular Economy	13.6 billion RMB (1,76 billion €) during 12th five-year plan	
	Ministry of Science and Technology (MOST)	14.7 million RMB to 28.2 million RMB (1,9 to 3,6 million €) for the 2018 projects	
	National Natural Science Foundation of China (NSFC)		
South Africa	Green Fund	50 million € (800 Million Rand) initial seed money	
	Renewable Energy Independent Power Producer Programme (REIPPP)	n/a	
	SWITCH Africa Green Programme	1,460 million € (2014-2017)	
Colombia	Sustainable Recycling Industries in Colombia (funded by SECO, State Secretariat for Economic Affairs, Switzerland)	€ 357.000 (2019-2022)	
Ecuador	Solving the e-waste problem in Latin America, funded by UNIDO GEF	491.250 € (2018-2023)	
	Enhancing the Social Value of the Circular Economy in Latin America, funded by VLIR-UOS, Belgium	€ 280.000 (2018-2021)	
	Ecuador Mahi, funded by WWF	n/a	
Peru	Sustainable Recycling Industries in Peru (funded by SECO, Switzerland)	357.000 € (2019-2022)	
	Solving the e-waste problem in Latin America, funded by UNIDO GEF	391.250 € (2018-2023)	
	The Sustainable Urban Mobility in Secondary Cities in Peru (DKTI). Funded by GIZ	n/a	

Country	Programme (owner)	Original survey data behind annual financial volumes	Issues to which the financial volume is spent
Italy Group			
Botswana	Italian Ministry for the Environment and Land and Sea and Botswana Ministry of the Environment, Wildlife and Tourism	Co-operation in the field of Climate change vulnerability, risk assessment, adaptation and mitigation: ca. 4.000.000 € until project ending.	
Cuba	Cuba Ministry of science, technology and environment AND Italian Ministry for the environment, land and sea	Cooperation in the field of climate change vulnerability, risk assessment, adaptation and mitigation: 2.000.000 € until all projects end.	
Djibouti	Djibouti Ministry of habitat, planning and environment AND Italian Ministry for the environment, land and sea	Cooperation in the field of climate change vulnerability, risk assessment, adaptation and mitigation: 1.100.000 € for two years.	
Eswatini	Ministry of tourism and environmental affairs of the kingdom of Swaziland AND Italian Ministry for the environment, land and sea	Cooperation in the field of climate change and sustainable energy: 2.000.000 € for two years.	
Ethiopia	Italian Ministry for the environment, land and sea	Cooperation in the field of mitigation and adaptation to climate change: 4.500.000 € until project ends.	
Iran	Biennal Plan of Action for the Implementation of Environmental Cooperation MoU	n/a	
Lesotho	Lesotho Ministry of energy and meteorology AND Italian Ministry for the environment, land and sea	Cooperation in the field of climate change vulnerability, risk assessment, adaptation and mitigation: 2.000.000 €.	
Maldives	Technical agreement on sustainable development cooperation, Maldives Ministry for the environment and energy AND Italian Ministry for the environment, land and sea	180.000 € until all projects end.	

Country	Programme (owner)	Original survey data behind annual financial volumes	Issues to which the financial volume is spent
Pacific Ocean Small Insular Countries (Kiribati, Micronesia, Palau, Solomon Islands, Tuvalu, Vanuatu)	Pacific Ocean Small Insular Countries local government AND Italian Ministry for the environment, land and sea	Cooperation in the field of climate change vulnerability, risk assessment, adaptation and mitigation 11.300.000 € for 10 years (2007-2017)	
Sudan	Sudan Ministry of environment, physical development and natural resources AND Italian Ministry for the environment, land and sea	Cooperation in the field of climate change vulnerability, risk assessment, adaptation and mitigation: 75.000 € until all projects end.	
Union of Comoros	Comoros Ministry of production, environment, energy, industry and handicrafts AND Italian Ministry for the environment, land and sea	Cooperation in the field of climate change vulnerability, risk assessment, adaptation and mitigation: 1.500.000 € for two years.	

Currencies were converted into € by the authors by employing exchange rates occurring between 1st of August 2019

n/a = data not available

 Indicated financial volume exclusively spent to circularity increasing projects

 Indicated financial volume also spent to other than circularity issues

Table 24: Examples of actors for CE in all analysed countries

Country	Actors (examples)		
	Network / Cluster	Industry	Other
Australia	Green Industries SA Circular Economy Australia CE Innovation network (New South Wales)		JW (Japan Industrial Waste Information Center)
Japan		REPROTEC.LAB CO., LTD	
South Korea	Gyeonggi Technopark Ulsan Eco-industrial Park Korea Environmental Industry Association Korea Water and Wastewater works Association	Daemyung Esco Co., LTD	R&D Center for Valuable Recycling
Taiwan	Taiwan Circular Economy Network	Singtex Industrial Co., Ltd. Chen Ya Resources Technology Corp. AU Optronics Corp San Fu Chemical Co., Ltd	Environmental Protection Bureau of Tainan City Government Shalun Smart Green Energy Science City Office
USA	UPcyclers Network! Automotive Parts Remanufacturers Association Remanufacturing Industries Council	Caterpillar - Cat Reman Lehigh Technologies (Michelin Tires) Goodwill Industries North Face Renewed Wasteless iFixIt BioCellection FullCycle Bioplastics Industrial Organic Zero Waste Daniel Xerox Jasper Engines & Transmissions	Closed Loop Fund (Partners) The Remade Institute Circular CoLab Rochester Institute of Technology Boston University
India		Enkay Enviro Services Pvt. Ltd	Pimpri-Chinchwad Municipal Corporation Adar Poonawalla Clean City Initiative National Environmental Engineering Research Institute (NEERI)

Country	Actors (examples)		
	Network / Cluster	Industry	Other
PR China	China Association of Circular Economy Tianjin Ziya Circular Economy Park China Resource recycling association Internet + Resource Recycling & Reusing Industrial Promotion Alliance	Beijing Cement Plant Co., Ltd Huaxin Environmental Protection Co. Ltd Tangshan Sanyou Group Co, Ltd. Sichuan Deepblue Environmental Technologies Co., LTD ZXXK Environmental Protection Technology (Beijing) Co., Ltd. Tsingtao Brewery Co., Ltd.	Internet + Resource Recycling & Reusing Industrial Promotion Alliance
South Africa	African Circular Economy Network (ACEN) African Circular Economy Alliance (ACEA) Circular Economy Club	Circular-Vision Wizeimpact Use-it	Green Cape Western Cape Industrial Symbiosis Programme (WISP) Council for Scientific Research and Industrial Research National Cleaner Production Center
Colombia	Red de Empresas Sostenibles, RedES-CAR Circular Economy Club	RECYCLABLES GRUPO NUTRESA	Red Colombiana de Análisis de Ciclo de Vida CNPML – Centro Nacional de Producción Más Limpia from Colombia
Ecuador	Circular Economy Club	Holcim ADELCA	Centro Ecuatoriano de Eficiencia de Recursos
Peru	Red Peruana Ciclo de Vida y Ecología Industrial (PELCAN) Circular Economy Club	CICLO San Antonio Recycling	Grupo GEA (National Cleaner Production Centre in Peru)
Iran	Association of IRAN Recycling Industries		