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Towards Circular cities. A methodological framework from Europe to Mediterranean Islands

Ginevra Balletto

UNIVERSITÀ DEGLI STUDI DI CAGLIARI

Co-funded by the Erasmus+ Programme of the European Union

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Associate Professor of Urban and Spatial Planning, DICAAR, University of Cagliari (Italy).
The main research topics are related to geospatial planning in the multiple transitions (demographic, energy, ecological, and digital).

National research project Cluster Top Down - POR FESR Sardinia 2014/2020. MEISAR: Sustainable building and infrastructure materials - recycled aggregates. The study has that as its main purpose to encourage the use of the concrete aggregates obtained from the recycling of construction materials e demolition

https://scholar.google.com/citations?user=hMuIcA4AAAAJ&hl=it

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City and University of Cagliari

The University of Cagliari (Italian: Università degli Studi di Cagliari, **UniCa**) is a public research university in Cagliari, Sardinia, Italy. It was founded in 1606 and is the largest university on the island. The university is organized into 11 faculties and offers a wide range of undergraduate and postgraduate programs.

The University of Cagliari has approximately 24,750 enrolled students. This includes both undergraduate and postgraduate students.

Cagliari City: population: Approximately 154,000 people
Area: 85 square kilometers (33 sq mi)

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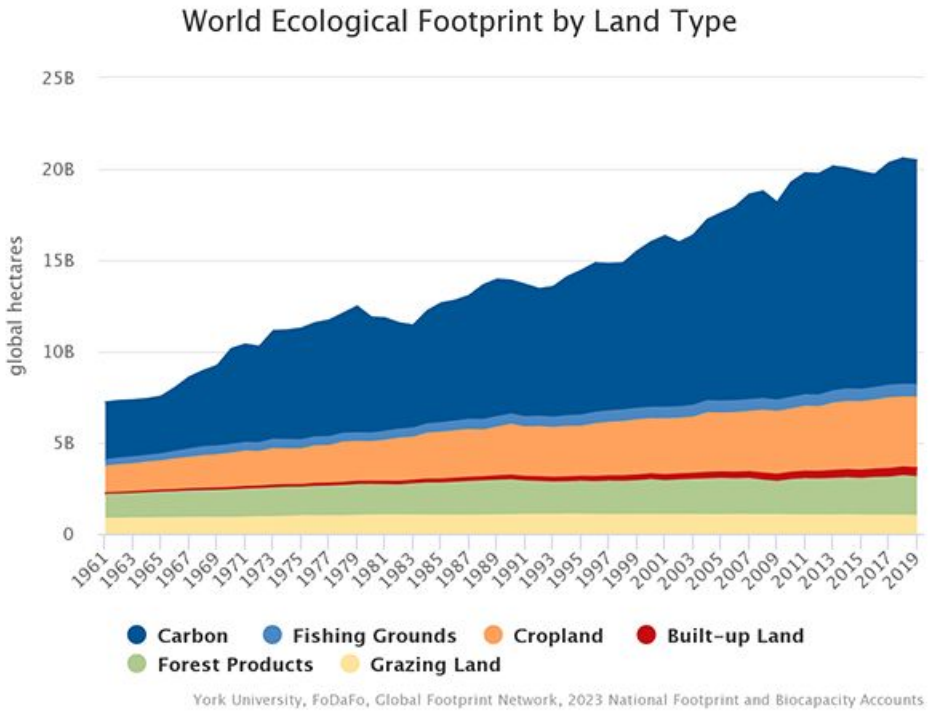
Cagliari is the capital and largest city of the island of Sardinia, an autonomous region of Italy. It is located on the southern coast of the island, on the Gulf of Cagliari. Cagliari is a vibrant and cosmopolitan city with a rich history, culture and beautiful beaches and other natural attractions.

Overview



The Global Footprint highlights growth in the production and consumption of natural resources and "overshoot" represents the level by which human population's demand overshoots the sustainable amount of biological resources regenerated on Earth.

The circular economy is a model of production and consumption that contrasts with the traditional linear economy (take, make, dispose). In a circular economy, the goal is to keep products and materials in use for as long as possible. This is done through a variety of methods, including:

Designing products for durability and repairability
Reusing products
Refurbishing products
Remanufacturing products
Recycling materials

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I Introduction to Circular Cities (first recording)

1. Definition and key principles of the circular economy
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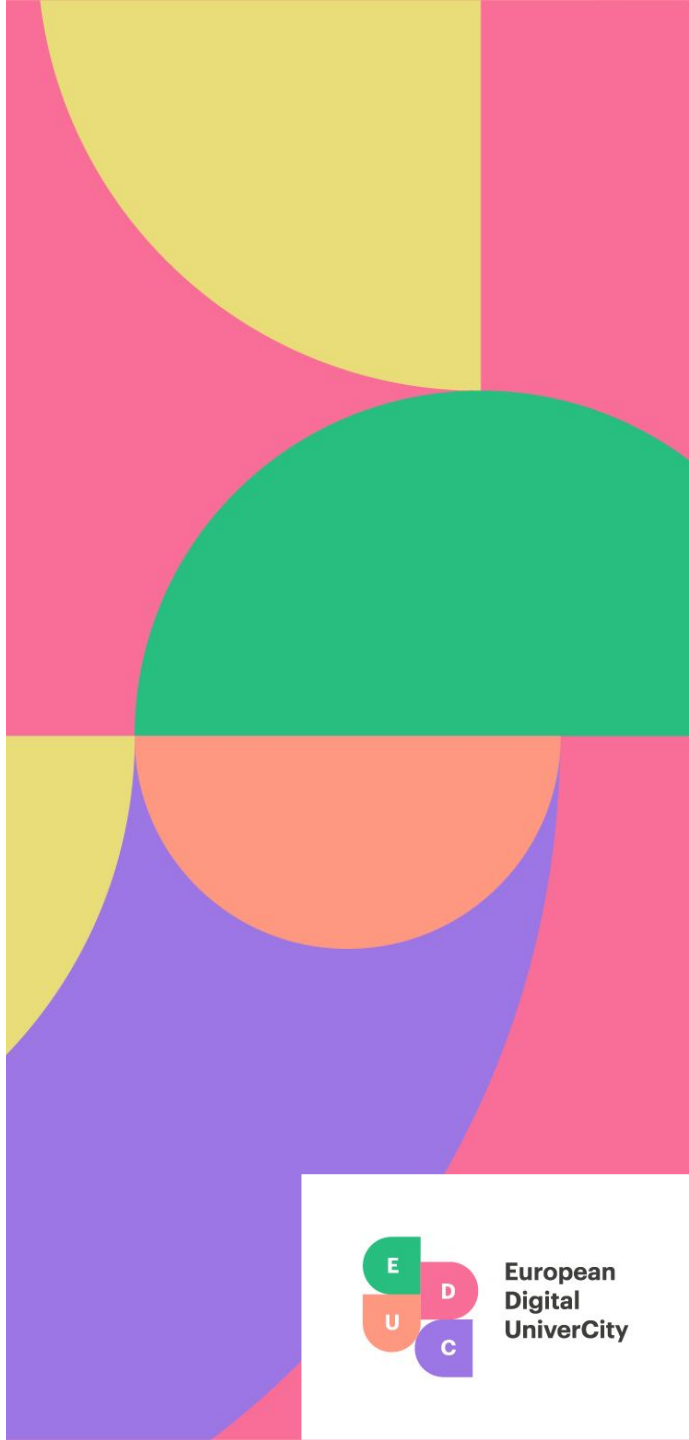
5. Examples of successful circular economy (Region and City)
6. Conclusion

II Key roads for a Circular Cities (second recording)

1) Reduce resource consumption and waste production
2) Extend the life cycle of products
3) Promote urban regeneration
4) Create circular supply chains for key materials (CDW, glass, metals,.urban waste)
5) Adopt circular business models New Weber Model (Borruso G. et al, 2019)
6) Encourage innovation and collaboration for circularity (Social map)



I. Introduction to Circular Cities

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1. Definition and key principles of the circular economy

A circular economy is an economic system aimed at eliminating waste and pollution, circulating products and materials at their highest value, and regenerating nature. In a circular economy, a product's value is retained for as long as possible. This is done by designing products that are easy to repair, reuse, and recycle. When a product reaches the end of its useful life, it is either broken down into its raw materials and used to make new products.

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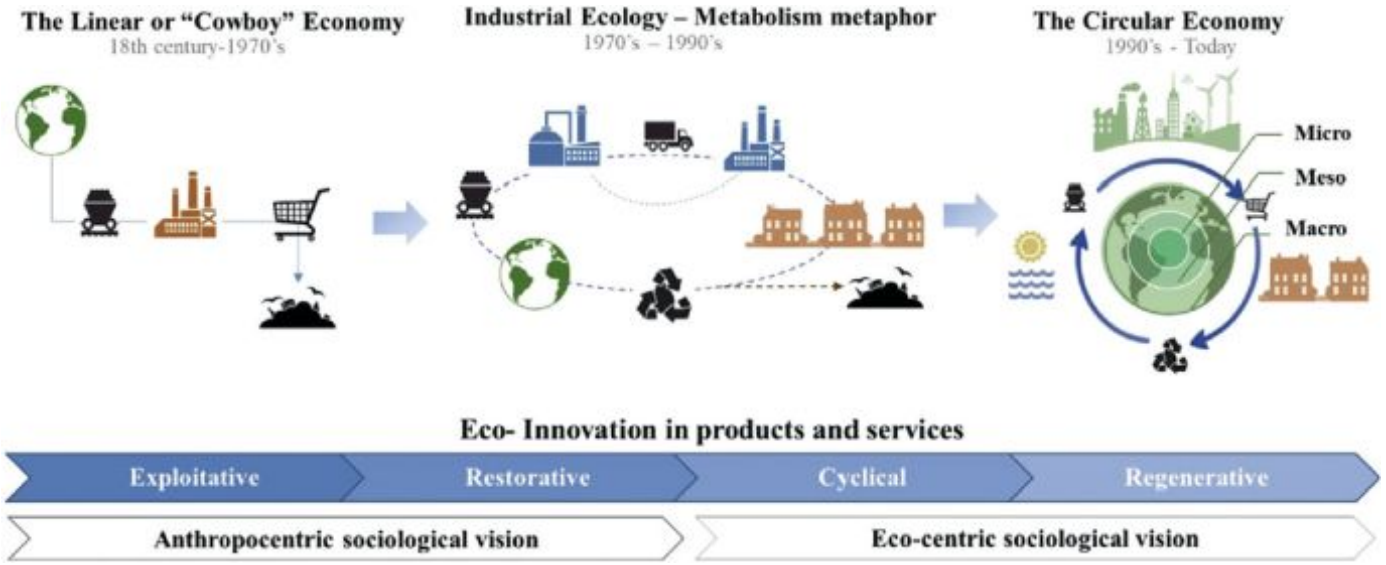
Tirado R, Aublet A, Laurenceau S, Habert G. Challenges and Opportunities for Circular Economy Promotion in the Building Sector. *Sustainability*. 2022; 14(3):1569. https://doi.org/10.3390/su14031569

I. Introduction to Circular Cities

2. From linear model to circular model

Our current "take-make-dispose" linear economy is unsustainable. A circular economy offers a solution. It focuses on keeping resources in use for as long as possible. This means designing products for durability, repair, and reuse. It also prioritizes recycling and composting to turn waste back into valuable materials.
The transition from a linear to a circular economy is a fundamental shift in how we think about and manage resources. It's a move away from the traditional "take-make-dispose" model towards a more sustainable approach that aims to keep resources in use for as long as possible.



The goal? Minimize waste, extend product life, and decouple economic growth from resource depletion.

Michelini, G., Moraes, R. N., Cunha, R. N., Costa, J. M., & Ometto, A. R. (2017). From linear to circular economy: PSS conducting the transition. *Procedia Cirp*, *64*, 2-6. https://link.springer.com/chapter/10.1007/978-3-031-42220-1_1

2. From linear model to circular model

The origin of the circular economy cannot be traced back to a precise historical moment. The academic theories emerged around the 60s - 70s, but the greatest impulse is due to Ellen MacArthur (born 8 July 1976). She's a British sailor and environmentalist who is best known for her record-breaking solo circumnavigations of the globe. In recent years she has become even more famous for her work on the circular economy. MacArthur founded the Ellen MacArthur Foundation in 2010 to promote the circular economy. The foundation has published a number of influential reports on the subject, and has worked with businesses, governments, and other organizations to implement circular economy principles.

I. Introduction to Circular Cities

3. Circular cities

Cities are potential engines of the transition towards a circular economy. With around 75% of the European population living in urban areas, most of the consumption, waste production, and emission of greenhouse gasses occurs in cities. In addition, European cities have a high density of knowledge, data, and capital. This concentration enables cities to drive the circular economy agenda forward and unlock related economic, environmental, and social benefits.Alongside the Sustainable Development Goals and climate objectives , the transition to a circular economy will support city leaders as they deliver against many of their other priorities, e.g. improved housing, mobility, and economic development.

Are some of the key characteristics of a circular city: **Reduced waste generation; Extended product life spans; Closed-loop systems; Renewable energy source; Sustainable infrastructure.** According to this new approach, more and more cities are: clearly implementing and embedding circular economy principles and roadmaps successfully through a wide range of activities; prioritising progress on circular economy measurement and reporting to support their strategic decision making and transition plans; beginning to realise the untapped potential of the circular economy for regenerating nature; harnessing the potential of the circular economy to achieve climate goals, as well as build resilience and enable a just transition.

https://research-and-innovation.ec.europa.eu/research-area/environment/circular-economy/circular-cities-and-regions-initiative_en

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4. Challenges and opportunities for cities in adopting a circular model

Cities consume a lot of resources. Switching to a circular model, where things are reused and recycled, offers advantages but comes with difficulties. The challenges include high initial costs for new systems, needing good data on resource use, and creating policies that encourage circular practices. It also requires collaboration between businesses, community, and public administration.

On the bright side, a circular city can become more efficient with resources, reducing costs and environmental impact. New businesses in repair, reuse, and recycling can create jobs. Less waste going to landfills keeps cities cleaner and reduces strain on waste management.

A circular model is an investment in a more sustainable, innovative future for cities: eliminate waste and pollution, circular products and materials (at their highest value) and regenerate nature.

Schurig, S., & Turan, K. (2022). The concept of a ‘regenerative city’: How to turn cities into regenerative systems. *Journal of Urban Regeneration & Renewal*, *15*(2), 161-175.

3. Circular cities

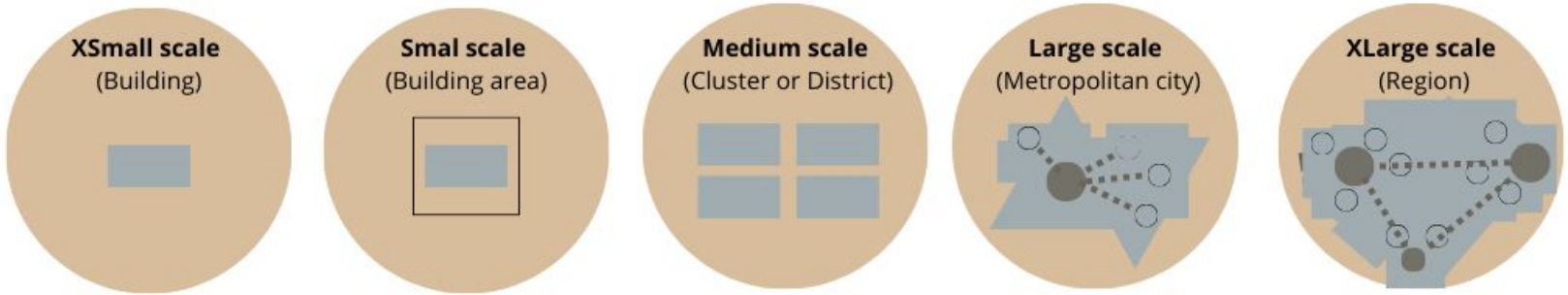
A circular city is built on seven main pillars:

- Recycled materials
- Innovation and value
- Protects biodiversity
- Adaptive and resilient
- Culture and society
- Health and wellness
- Renewable energy

and urban scalas:

from building to region

urban ecosystem of the circular city



Balletto G, Ladu M, Camerin F, Ghiani E, Torriti J. More Circular City in the Energy and Ecological Transition: A Methodological Approach to Sustainable Urban Regeneration. *Sustainability*. 2022; 14(22):14995. https://doi.org/10.3390/su142214995

I. Introduction to Circular Cities

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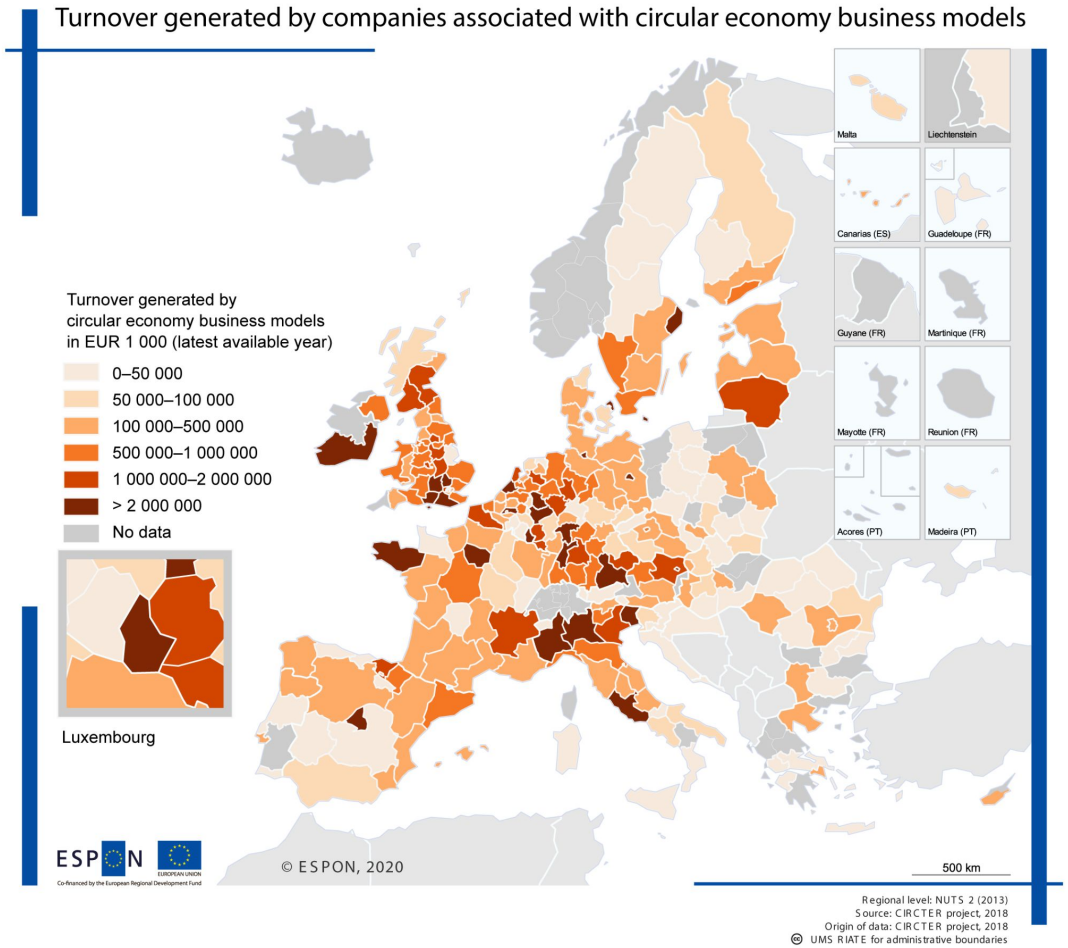
3.Examples of successful circular economy (Region and City)



One of the main building blocks of Europe's new agenda for sustainable growth, the European Green Deal, is the circular economy action plan, adopted in 2020. This action plan aims to, among other things, ensure less waste is produced, make sustainable products the norm and make circularity work for people, regions and cities in the EU.

The European Commission adopted the new circular economy action plan (CEAP) in March 2020. It's one of the main building blocks of the European Green Deal, Europe's new agenda for sustainable growth.

It introduces legislative and non-legislative measures targeting areas where action at the EU level brings real added value.

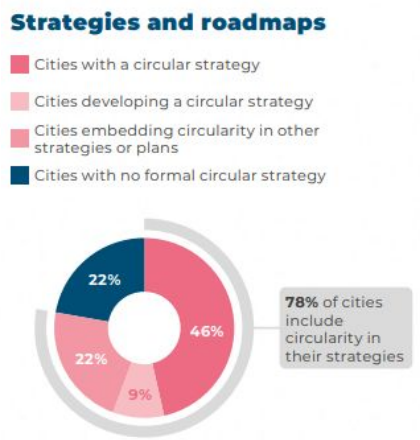
https://archive.espon.eu/topics-policy/publications/policy-brief-territorial-approach-transitioning-towards-circular-economy
https://environment.ec.europa.eu/strategy/circular-economy-action-plan_en

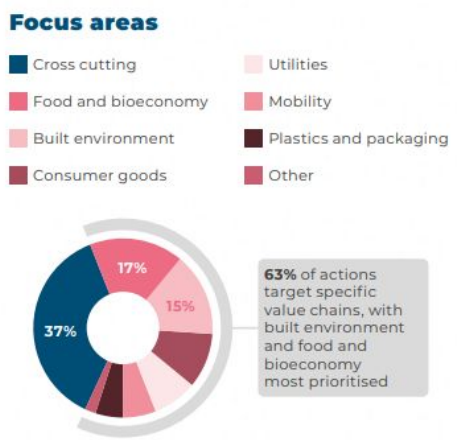
I. Introduction to Circular Cities

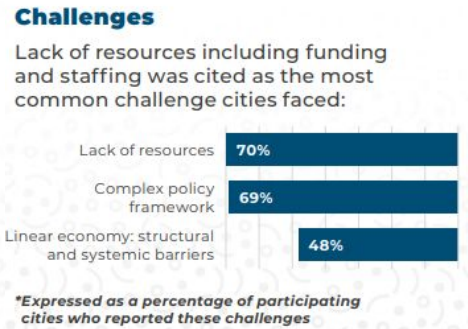
3.Examples of successful circular economy (Region and City)

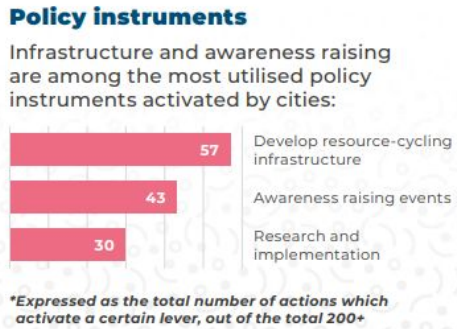
CCD Report 2024 offers a comprehensive vision on the implementation of the circular economy in European cities and features contributions from 54 cities and metropolitan areas, representing 16 million inhabitants.

From the comparing this year's to last year's, shows that cities across Europe have made varying degrees of progress towards the ten commitments, with progress ranging between 2% and 20%







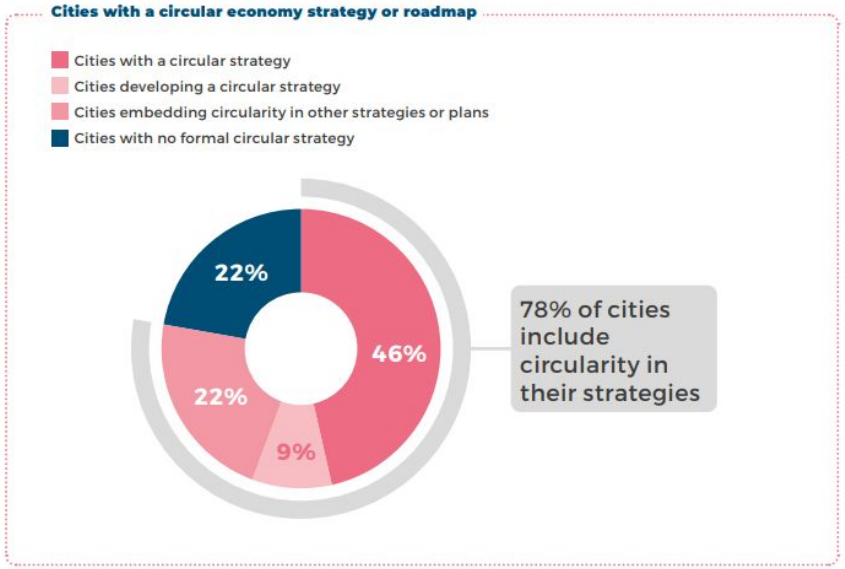


https://circularcitiesdeclaration.eu/about/ccd-report
https://iclei-europe.org/
https://www.circle-economy.com/

I. Introduction to Circular Cities

3.Examples of successful circular economy (Region and City)

Cities are combining implementation strategies with different policy instruments, i.e. methods, mechanisms or tools that governments use to achieve expected outcomes, into action plans.
These policy instruments and levers have been classified using the Urban Policy Framework developed by Circle Economy and the Ellen MacArthur Foundation, which identifies 42 policy instruments grouped into five main categories — mobilise, educate, manage, incentivise, and regulate — representing the main types of levers available to cities in line with the ten CCD commitments.



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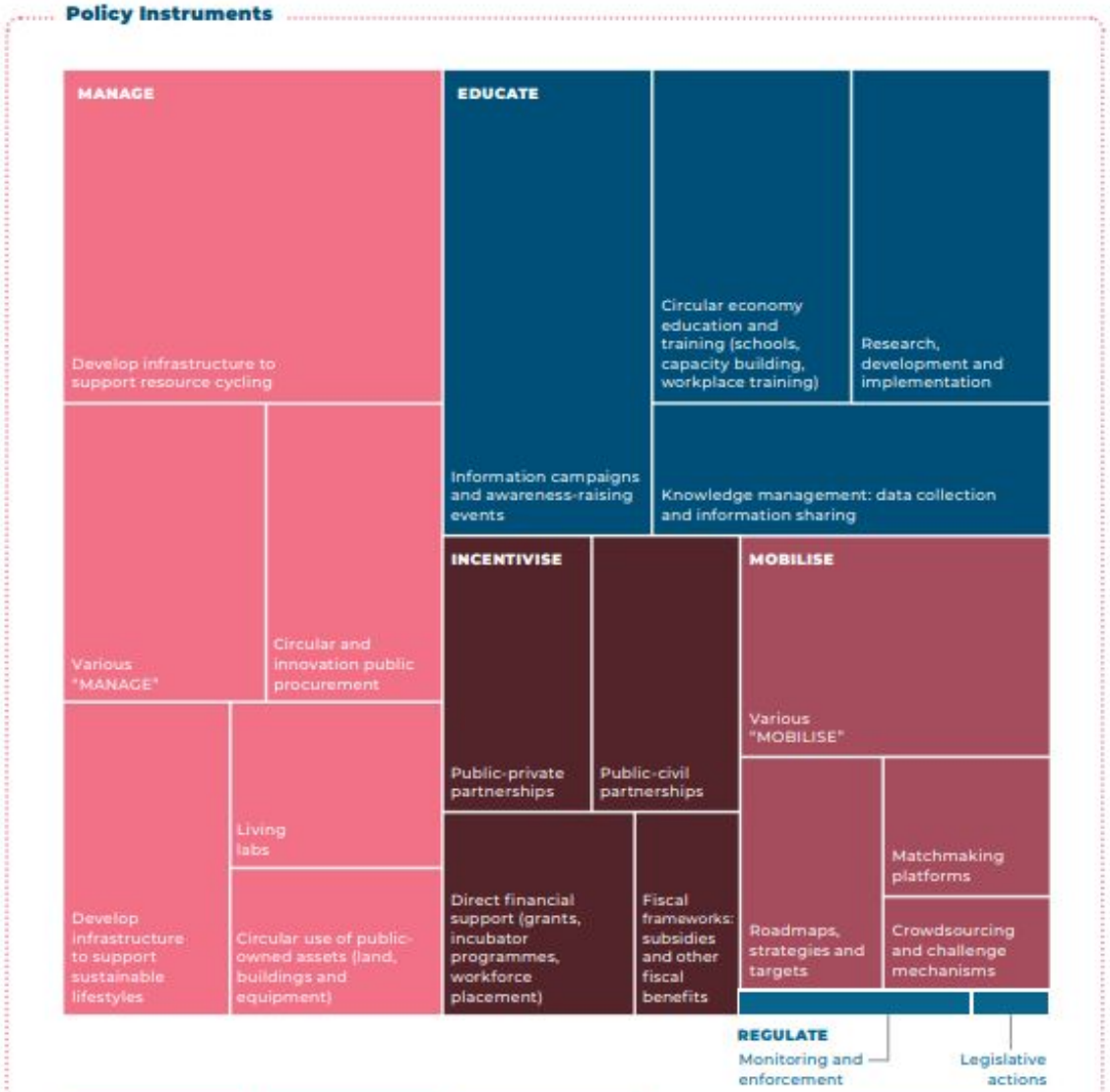

MOBILISE	EDUCATE	MANAGE	INCENTIVISE	REGULATE
Setting the direction of and building momentum towards long-term change, while also determining how this direction is decided and governed.	Increasing the overall levels of awareness and building the necessary skills and knowledge around the circular economy to foster long-term change.	Influencing the use and function of physical and material elements within the urban environment.	Sending market signals and support to businesses, citizens, and governments to promote certain activities.	Changing the rules of the systems to achieve compliance through enforcement.
1, 3, 8, 9, 10	2	4, 5	5, 6	7, 8

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3. Examples of successful circular economy (Region and City)

The City of Amsterdam as frontrunner in sustainability and circular thinking has published its Circular Strategy 2020-2025. The City aims to both significantly reduce its environmental footprint, and make Amsterdam thrive. Two main goals are to halve the use of primary raw materials by 2030 and become 100% circular by the year 2050.

Amsterdam focuses on three value chains with related ambitions:

Ambition of about of Food and organic waste streams
1. Short food chains provide a robust sustainable food system
2. Healthy and sustainable food for the people
3. High-quality processing of organic waste streams

Ambition of about of Consumer goods:
1. The City sets the right example by reducing its consumption
2: Using what we have more sparingly
3. Amsterdam makes the most of discarded products

Ambition of about of Built environment
1. The transition to circular development requires a joint effort
2. The City sets the right example by formulating circular criteria
3. A circular approach to the existing city

https://www.amsterdam.nl/en/policy/sustainability/circular-economy/

I. Introduction to Circular Cities

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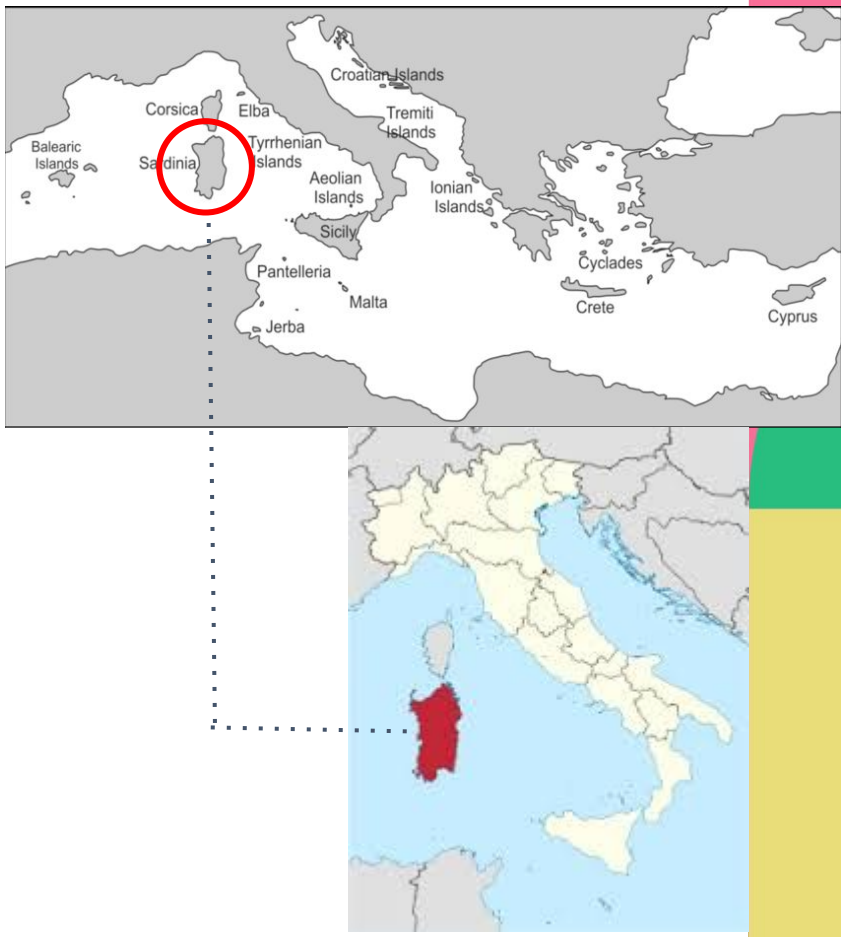
3.Examples of successful circular economy (Region and City)

The circular economy represents an important opportunity for Mediterranean islands to address challenges related to environmental sustainability and economic development. However, the Mediterranean islands lag far behind other regions.

Insularity is considered to be a permanent and unchangeable geographical feature which involves additional costs (transport, energy, waste management, public services, necessity goods and services) that hamper the development and competitiveness of the islands, while particularly exposing them to biodiversity loss and climate change. In this context, the categories of challenges for the EU's islands may be considered to include economic challenges, connectivity and accessibility challenges, green and environmental challenges, social challenges, and governance challenges.

Furthermore, in the islands some markets are closed, such as natural and recycled aggregates and low-cost construction materials.

MEISAR: Sustainable building and infrastructure materials recycled aggregates. Its main purpose to encourage the use of the concrete aggregates obtained from the recycling of construction and demolition materials through the evaluation of theoretical aspects (localization model) and operational aspects (optimization of company capabilities; environmental management)



https://medblueconomyplatform.org/wp-content/uploads/2022/07/2022_a-circular-blue-economy-for-the-mediterranean-switchmed.pdf
https://www.slideshare.net/slideshow/recycled-aggregatesmechanical-properties-and-environmental-sustainability/229664297

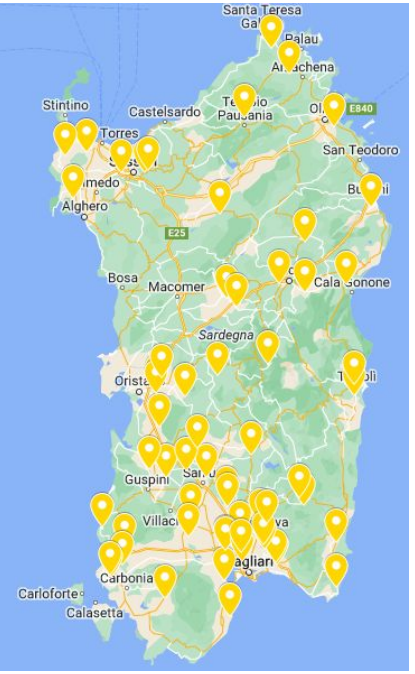
I. Introduction to Circular Cities

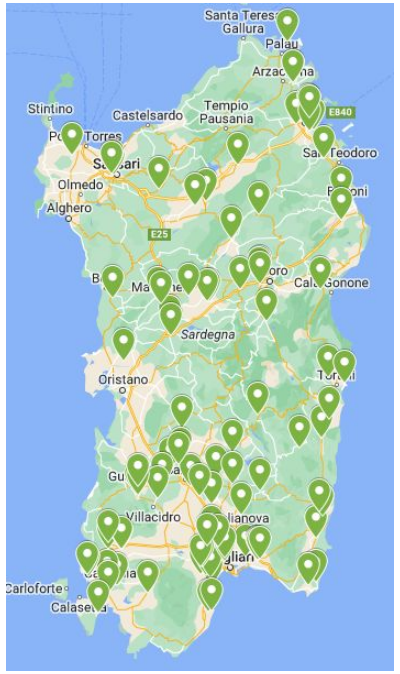
3.Examples of successful circular economy (Region and City)

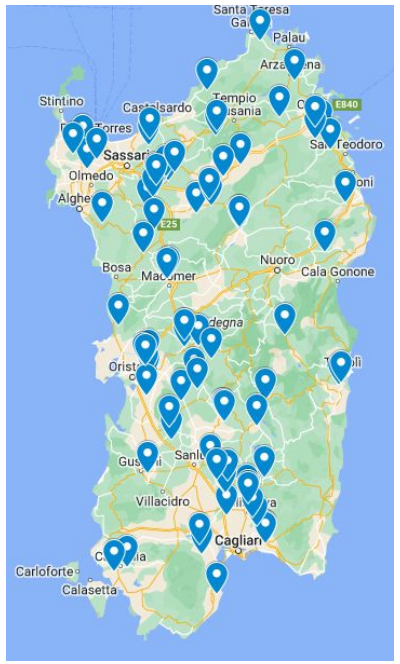
The circular economy is expressed thanks to the **industrial symbiosis** of proximity, as the collaboration and sharing of data and resources between different industries or companies within a proximity area.

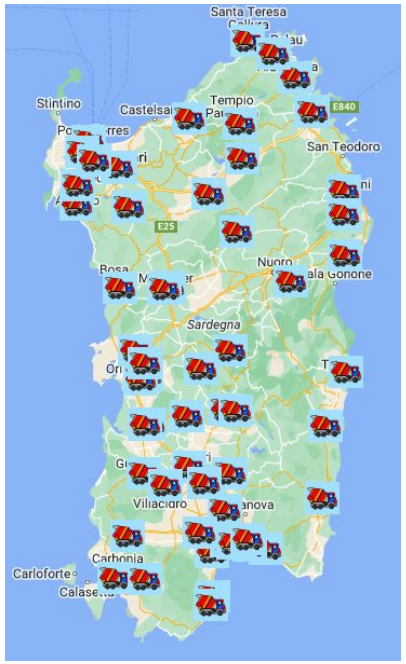
MEISAR_MAP

- **N. 61** Disposal plants or landfills
- **N. 101** Aggregate recycling plants
- **N. 91** Quarries of natural aggregates
- **N. 61** Concrete batching plants (R= 30Km)

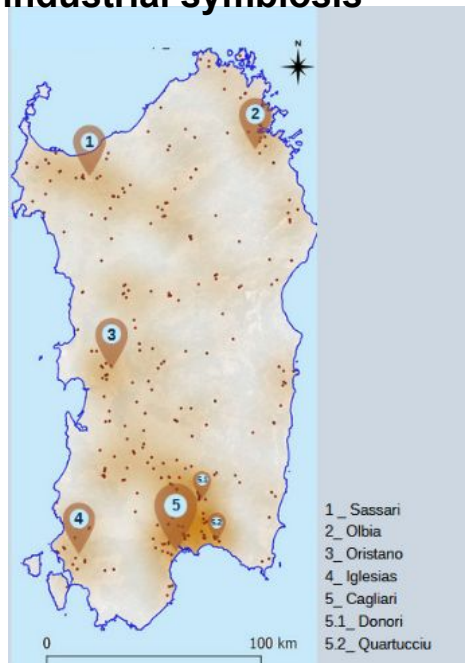








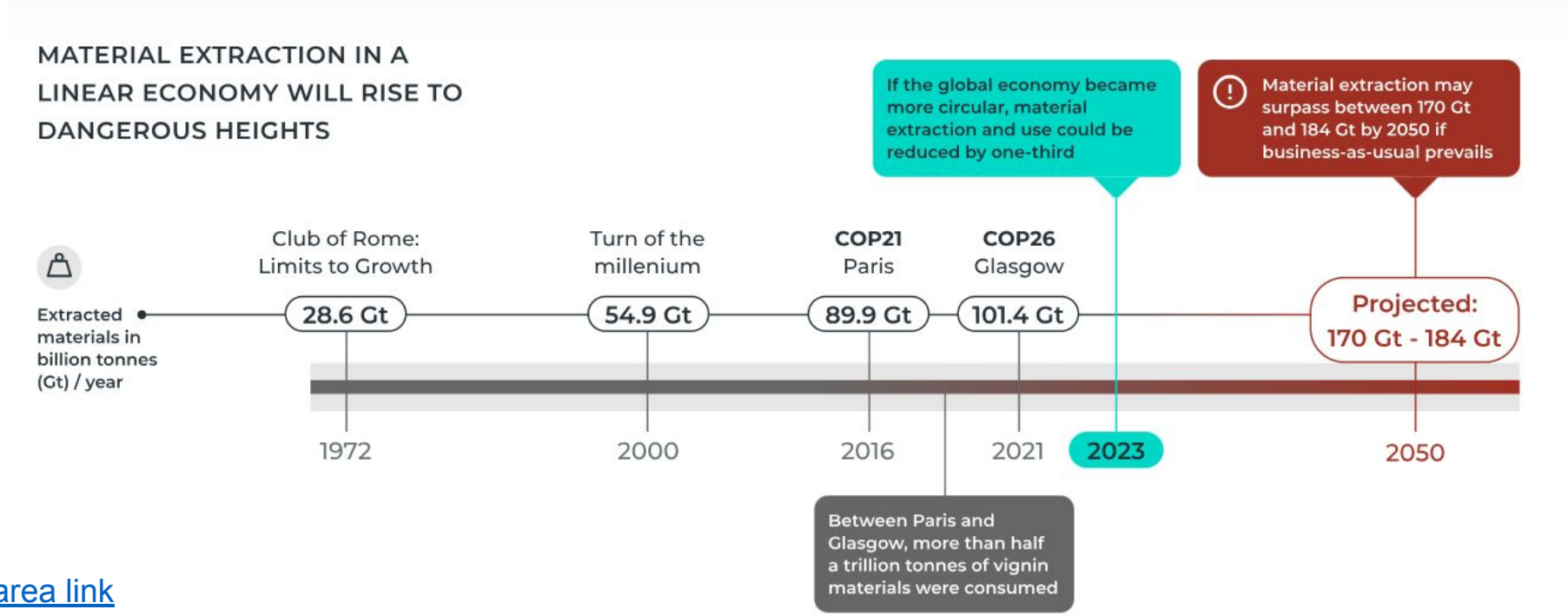
industrial symbiosis



The clusters of the industrial mix (1-5) represents the most favorable proximity area for the circular economy of recycled aggregates

Balletto, G., Sinatra, M., Sinatra, F., & Borruso, G. (2023). Industrial Symbiosis and Circular Urban Practices. In *International Conference on Innovation in Urban and Regional Planning* (pp. 14-24). Cham: Springer Nature Switzerland.
Balletto, G., Borruso, G., & Mei, G. (2019). Location theory and circular economy. Demolition, constructions and spatial organization of firms–an applied model to Sardinia Region. The case study of the New Cagliari Stadium. In *Computational Science and Its Applications–ICCSA 2019: 19th International Conference, Saint Petersburg, Russia, July 1–4, 2019, Proceedings, Part III 19* (pp. 535-550). Springer International Publishing.

3.Conclusion



Built area link
2017 - 2023

- The growth of cities requires a renewed economic approach in favor of circular cities;
- the islands require particular attention to encourage the use of recycled aggregates
- To promote the circular economy, for each economic sector it is necessary to evaluate the **industrial symbiosis-** localization models and operational aspects (optimisation of company capabilities; environmental management)-

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Thank you for your attention.

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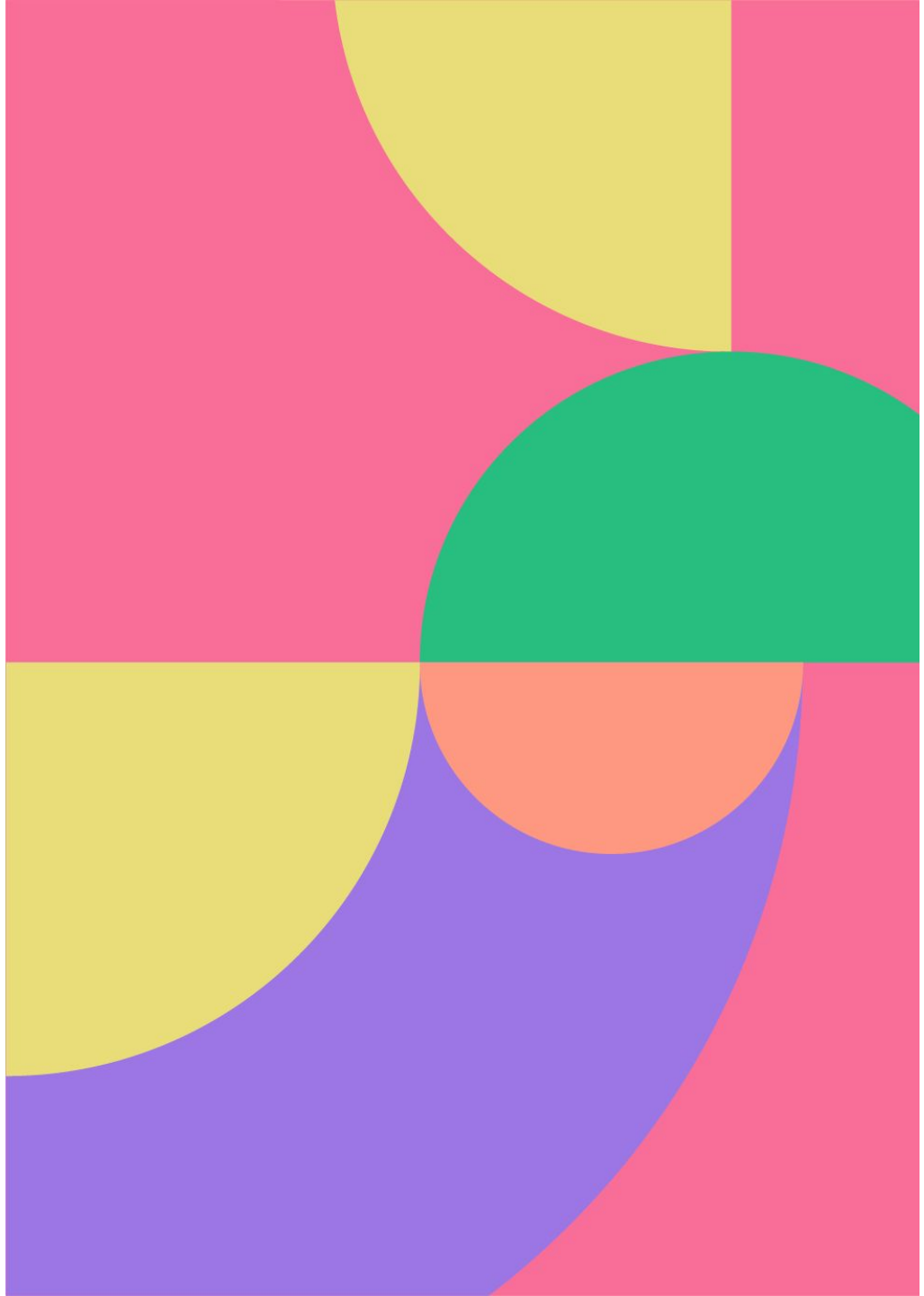

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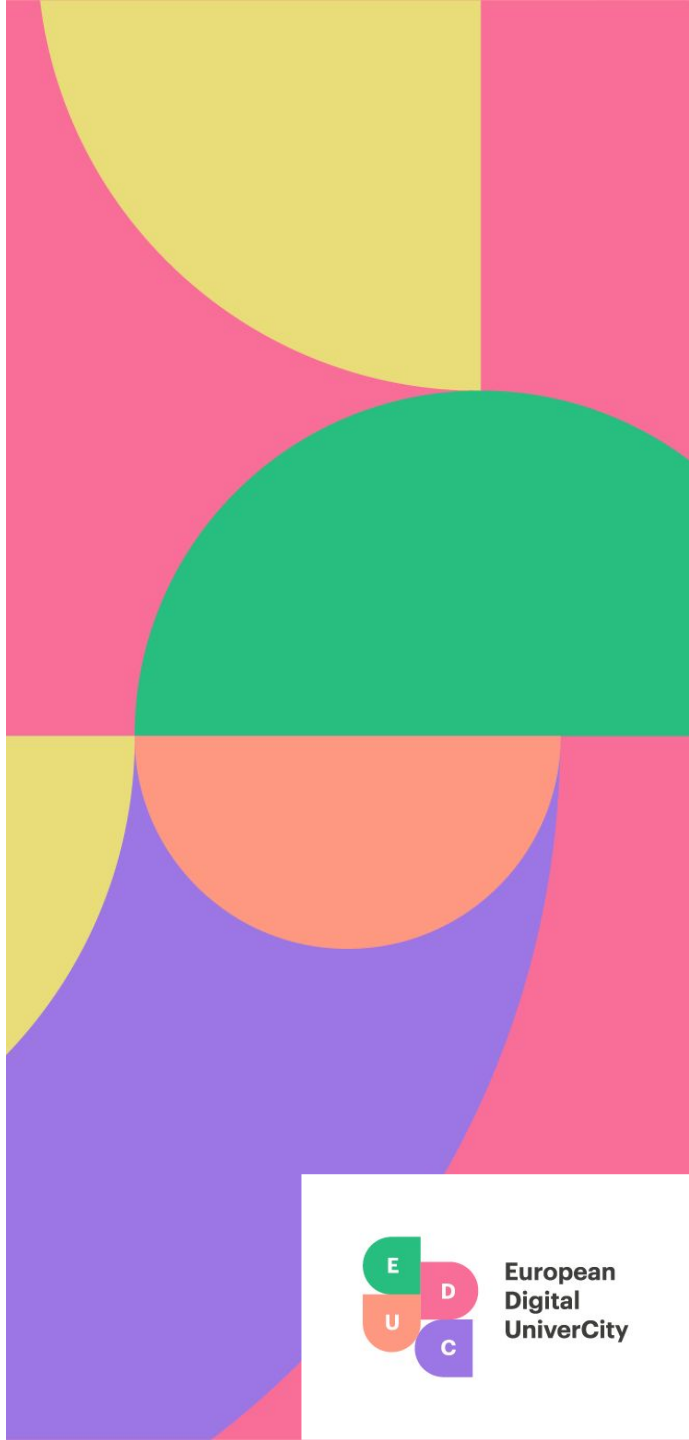
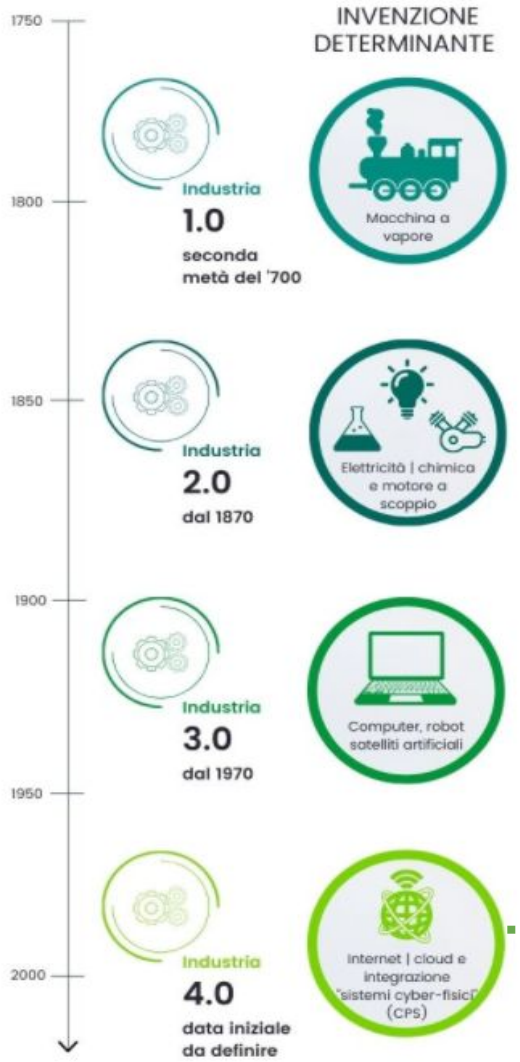
1) Reduce resource consumption and waste production - hybrid economy
2) Extend the life cycle of products
3) Promote urban regeneration
4) Create circular supply chains for key materials (CDW, glass, metals,.urban waste)
5) Circular business models: New Weber Model
6) Collaboration for circularity (Social map)
7) Conclusion



Overview stage 2

major inventions



Industry 4.0 is the term used to describe the fourth industrial revolution, which is characterized by the convergence of digital, physical, and biological technologies. This convergence has the potential to transform the way that products are designed, manufactured, and used, with a goal of increasing efficiency, sustainability, and productivity.

In particular, the main Industry 4.0 technologies used are:

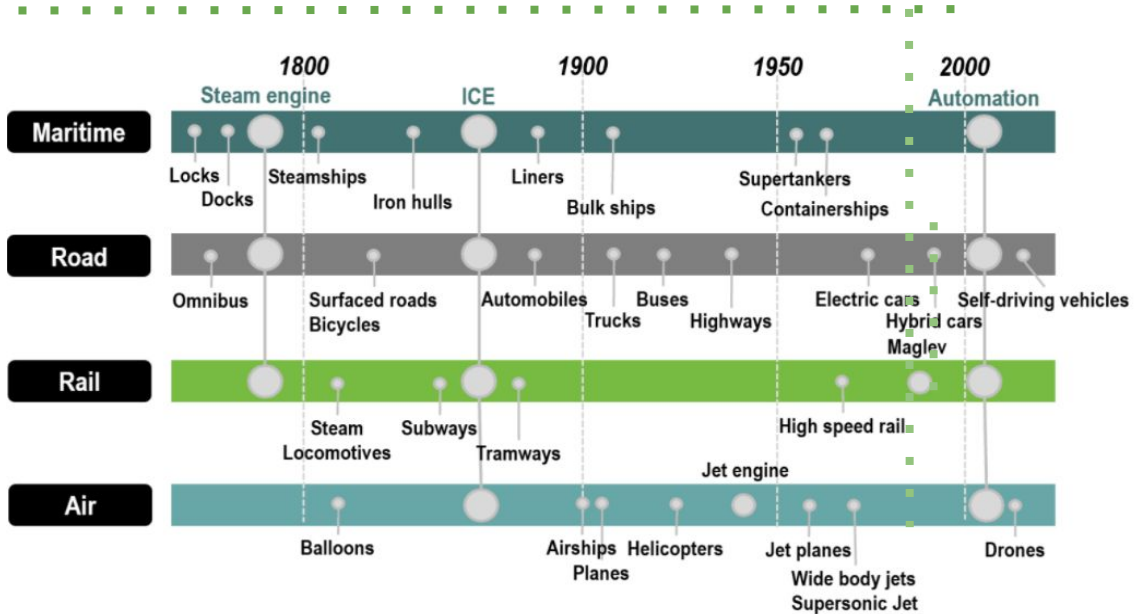
3D printing is being used to create products that are designed for disassembly and reuse.

Sensors are being used to monitor the condition of products in the field, which can help to extend their lifespan.

Big data analytics is being used to identify patterns in waste generation, which can help to develop more effective waste reduction strategies.

Industry 4.0 and the circular economy are two complementary concepts that can be used to create a more sustainable future

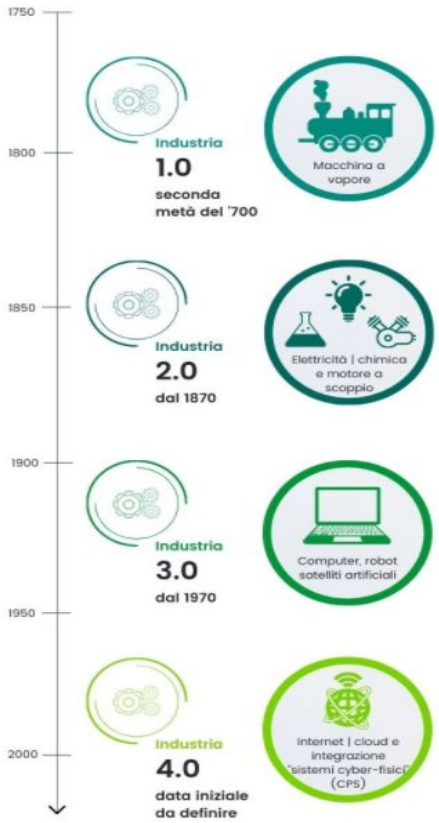
The timeline of innovations in major transportation systems



II Key roads for a Circular Cities

1) Reduce resource consumption and waste production - hybrid economy

Industrial phases



Pre industrial

Circular economy

Local (building, food, water..) materials, recovery of materials from monuments, … zero waste

Linear economy

The linear economy uses natural resources without worrying about their effective long-term availability, and waste and end-of-life products are mainly considered useless material. Furthermore, the socio-environmental impacts are neglected from the production, consumption of the product, up to its disposal of the waste.

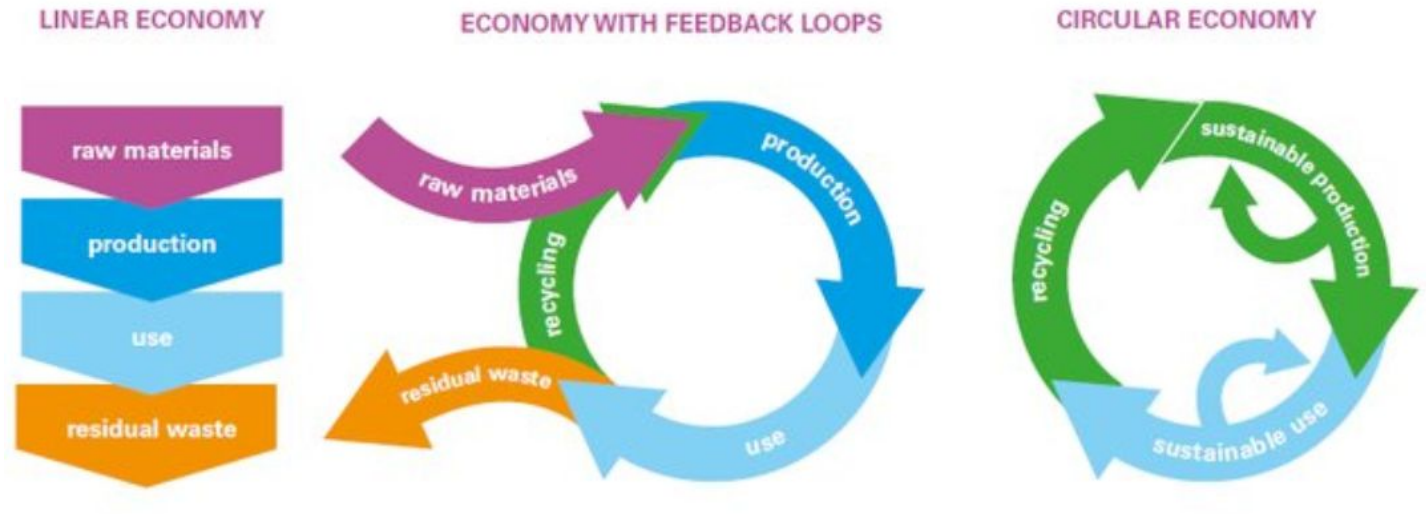
Hybrid economy
Linear and circular

The hybrid linear-circular economy is a model that attempts to combine elements of both the linear and circular economies. The goal of a hybrid economy is to create a system that is more sustainable than the current linear economy, but that is also more realistic and achievable than a fully circular economy.

II. Key roads for a Circular City

1. Reduce resource consumption and waste production - hybrid economy

A hybrid economy is likely to include some elements of both the linear and circular economies. For example, a company might use recycled materials to produce some of its products, but still dispose of some waste in landfills.
Or, a city might invest in renewable energy sources, but still have a significant amount of car traffic.
The specific mix of linear and circular elements in a hybrid economy will vary depending on the specific context.
However, all hybrid economies should share the goal of moving towards a more sustainable future.



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G. Balletto, A. Richiedei, M. Pezzagno and M. Ladu (2023) Hybrid Urban Services, Proximity Growth and Digital Connectivity. In L*iving and Walking in Cities New Challenges for Sustainable Urban Mobility 6-7-8 SEPTEMBER 2023 XXVI International Conference. Proceeding paper in prees*

II. Key roads for a Circular City

2. Extend the life cycle of products

Extending the life cycle of products refers to a set of strategies aimed at prolonging the useful life of products, minimizing waste, and promoting sustainability. This involves designing products for durability, facilitating maintenance and repair, encouraging reuse and repurposing, and promoting responsible disposal. By extending product life cycles, businesses can reduce their environmental footprint, save resources, and enhance their brand reputation.

key points:

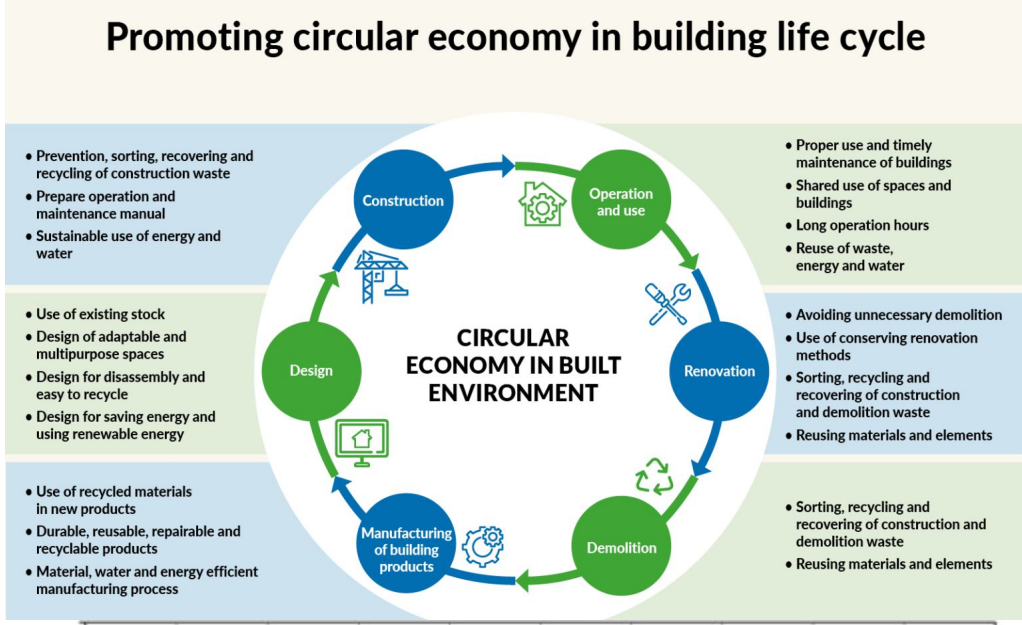
- Design for longevity
- Promote maintenance and repair
- Encourage reuse and repurposing
- Promote responsible disposal
- Educate consumers

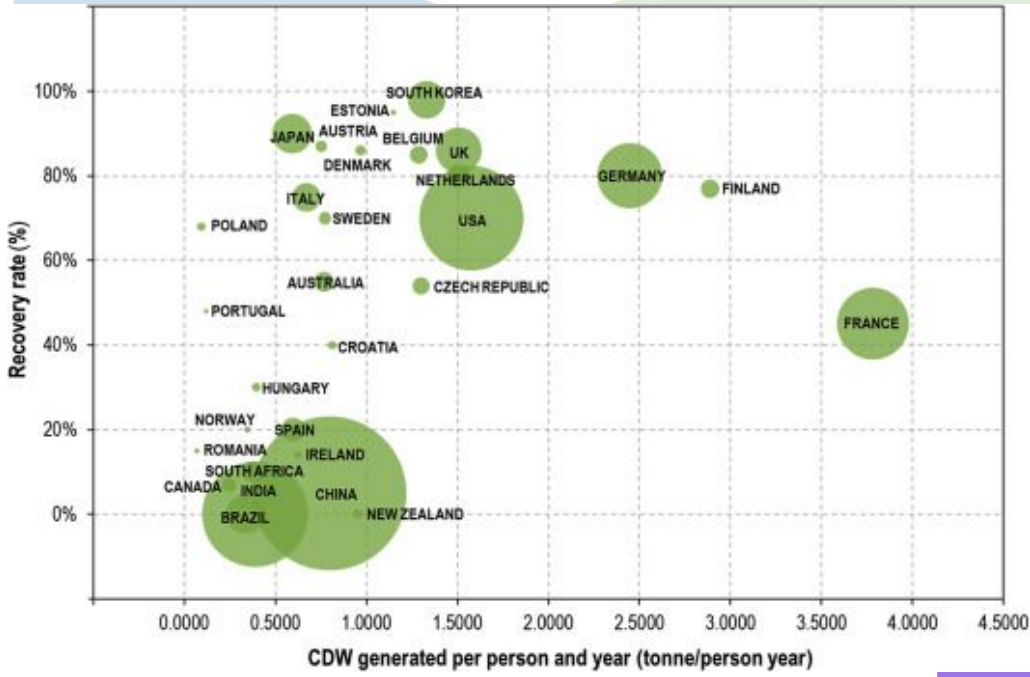
II. Key roads for a Circular City

2. Extend the life cycle of products

Overcoming Challenges and Shaping the Future

While progress has been made, challenges remain:
Contamination: Hazardous materials like asbestos can hinder recycling efforts.
Economic viability: Recycling sometimes faces competition from cheaper landfilling options.
Awareness: Increased public and industry awareness is crucial for driving behavior change.
To address these challenges and build a sustainable future, we must focus on:
Advanced recycling technologies: Developing innovative methods to recover valuable materials from complex waste streams.
Circular economy principles: Integrating CDW management into broader sustainability goals.
Stronger policies: Implementing regulations that incentivize recycling and discourage landfilling.





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II. Key roads for a Circular City

3. Promote urban regeneration

Urban Regeneration and the Circular Economy: A Synergistic Partnership
Urban regeneration and the circular economy are two sides of the same sustainable coin. Both aim to create more resilient, equitable, and environmentally friendly cities

Understanding the Connection

Urban Regeneration: This involves revitalizing declining urban areas to improve economic, social, and environmental conditions. It often includes repurposing buildings, developing green spaces, and enhancing infrastructure.

Circular Economy: This economic model focuses on eliminating waste and the continual use of resources. It emphasizes designing out waste, keeping products and materials in use, and regenerating natural systems.

Practical Examples

Repurposing Buildings: Transforming old industrial buildings into housing, offices, or community centers.
Creating Circular Districts: Designing neighborhoods with closed-loop systems for energy, water, and waste management.
Developing Green Spaces: Creating parks, urban gardens, and green roofs to improve air quality, reduce stormwater runoff, and enhance biodiversity.
Promoting Sustainable Mobility: Encouraging walking, cycling, and public transportation to reduce carbon emissions and improve public health.

Della Torre, S., Cattaneo, S., Lenzi, C., & Zanelli, A. (2020). *Regeneration of the built environment from a circular economy perspective* (p. 386). Springer Nature.

4. Create circular supply chains for key materials (CDW)

Construction and Demolition Waste (CDW) refers to the debris generated during the construction, renovation, repair, or demolition of buildings, roads, and other structures. This type of waste is typically heterogeneous, comprising a mix of materials such as:

- Inert materials: Concrete, bricks, tiles, plaster, soil
- Metals: Steel, iron, copper, aluminum
- Wood: Timber, plywood, wooden pallets
- Other materials: Glass, plastics, asbestos, gypsum board

C**DW waste poses significant environmental challenges:**

- Landfill congestion: Improper disposal contributes to landfill overcrowding.
- Resource depletion: Extraction of raw materials for new construction products increases resource consumption.
- Pollution: Leachate from CDW can contaminate soil and water.
- Climate change: The production of construction materials often involves high energy consumption and greenhouse gas emissions

II. Key roads for a Circular City

4. Create circular supply chains for key materials (CDW)

CDW once a significant environmental burden, is increasingly seen as a valuable resource. By adopting effective management strategies, we can transform this waste stream into a catalyst for economic growth and sustainability.

Economic Benefits of CDW Management

Resource Recovery: Recycling and reusing materials from CDW conserves natural resources, reduces production costs, and minimizes environmental impact.
Job Creation: The collection, processing, and recycling of CDW generate employment opportunities across various sectors.
Innovation: Developing new technologies and processes for CDW management fosters innovation and drives economic growth.

Effective CDW Management

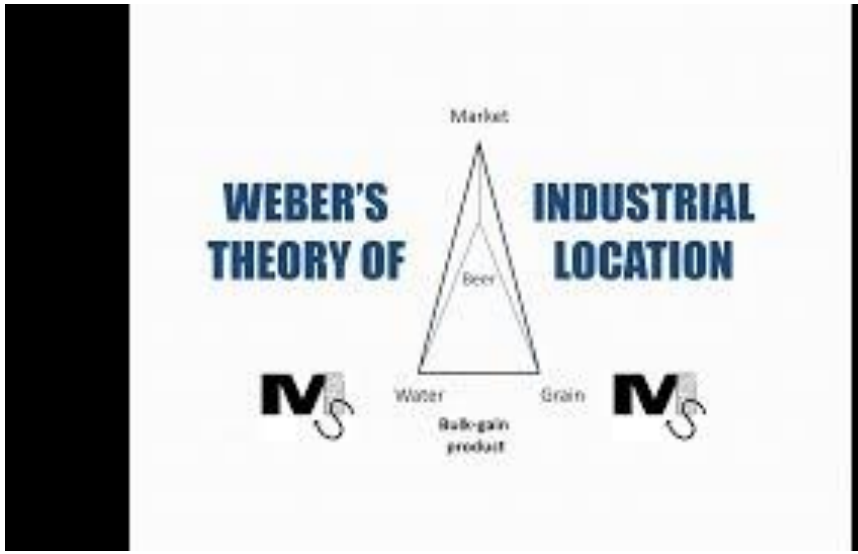
To maximize the benefits of CDW management, a systematic approach is essential:
Segregation: Sorting waste at its source into different material categories simplifies recycling and reduces contamination.
Recycling: Processing CDW into reusable materials such as aggregates, recycled concrete, and metal scrap.
Reuse: Incorporating recycled materials into new construction projects to create a circular economy.
Disposal: Landfilling should be the last resort for non-recoverable waste.

Common recycling processes for CDW waste include:
Concrete recycling: Crushing concrete into aggregates for use in new concrete mixtures.
Metal recycling: Sorting and melting metals for reuse in various industries.
Wood recycling: Reprocessing wood into products like mulch, particleboard, or biomass fuel.

5. Circular business models: New Weber Model

The starting point is Alfred Weber's model of industrial location (Weber, 1929), introduced by the German scholar in 1909. According to this model, the optimal location of production facilities is determined by transportation costs related to the distance between the sources of raw materials and markets, as well as the weight of raw materials and finished products. This model was used to explain the locational choices of the Ruhr region during Germany's industrial revolution.

Weberian new models are applicable to manufacturing firms that procure physical quantities of raw materials and **secondary raw materials**, intermediate goods, and fuel as inputs into the production process and produce a certain quantity of output. A key distinction in Weberian assumptions is that of resource classification. Weber specifically identifies localized resources, which have a fixed location in space, further categorized into "pure" (completely incorporated into the final product) and "gross" (losing weight, with only a portion incorporated). Other resources are defined as ubiquitous (or non-localized), with a more or less evenly distributed and accessible location in space.



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5. Circular business models: New Weber Model

The objective of Weberian models is to identify the location that minimizes transportation costs. In Weber's simplified model, which considers only two starting points – a resource location or extraction site (**raw materials and secondary raw materials)** and a market – this is achieved by minimizing the following formula:

$$T = tpr^{*}d(R) + tpm^{*}d(M)$$

T = Total transportation cost (expressed in tonne-kilometers)

t = Cost per tonne-kilometer
pr = Weight per unit of resource (input)
pm = Weight per unit of product (output)

d(R) = distance RF (resource location – production site)
d(M) = distance FM (production site – market location)

Production facility F will be located at a point between the resource location R and the market location M.
This location will depend on the relative weight of **raw materials and secondary raw materials** versus the finished product.

Church, R. L. (2019). Understanding the Weber location paradigm. *Contributions to Location Analysis: In Honor of Zvi Drezner's 75th Birthday*, 69-88.

Dore, S., & Gallo, A. (2023, June). Circular Economy and Reverse Logistics: An Analysis of Sustainable Business Models. In *International Conference on Computational Science and Its Applications* (pp. 495-511). Cham: Springer Nature Switzerland.

II. Key roads for a Circular City

6. Collaboration for circularity (Social map)

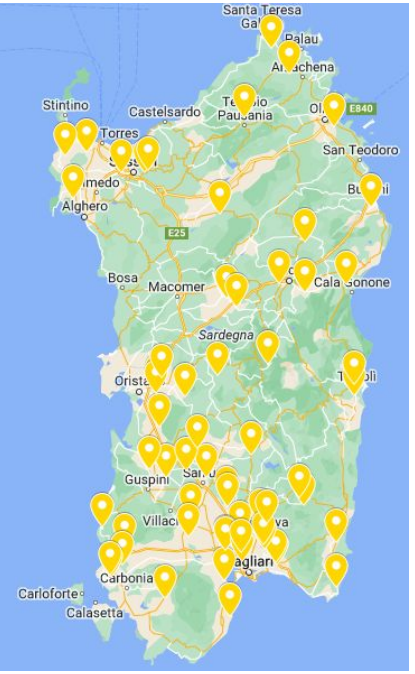
N. 61 Disposal plants or landfills

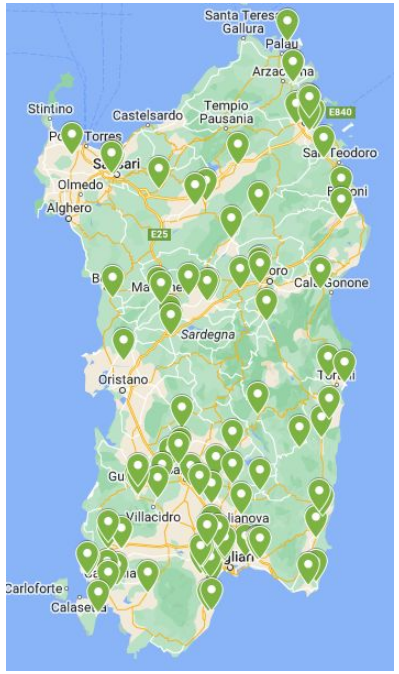
N. 101 Aggregate recycling plants

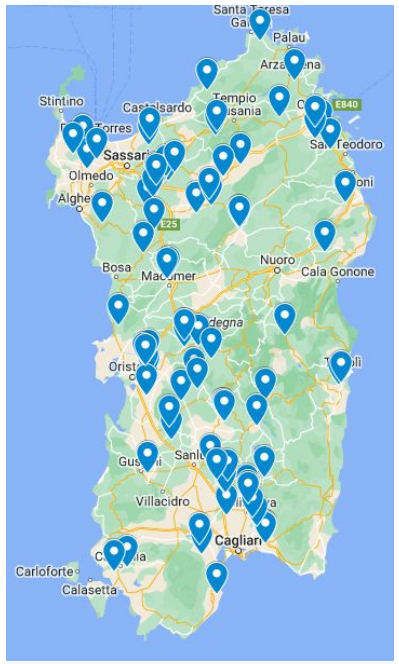
N. 91 Quarries of natural aggregates

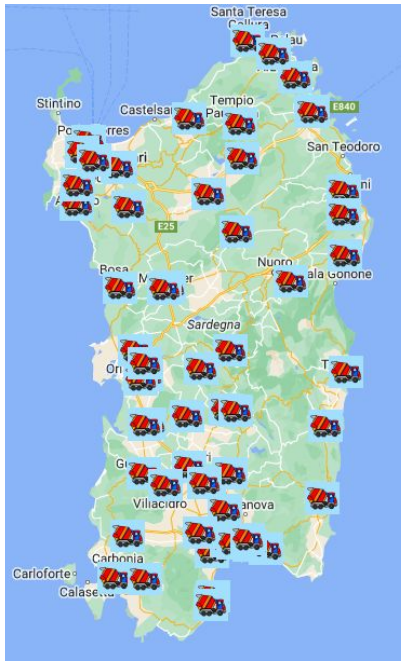
N. 61 Concrete batching plants (R= 30Km)

MEISAR_MAP

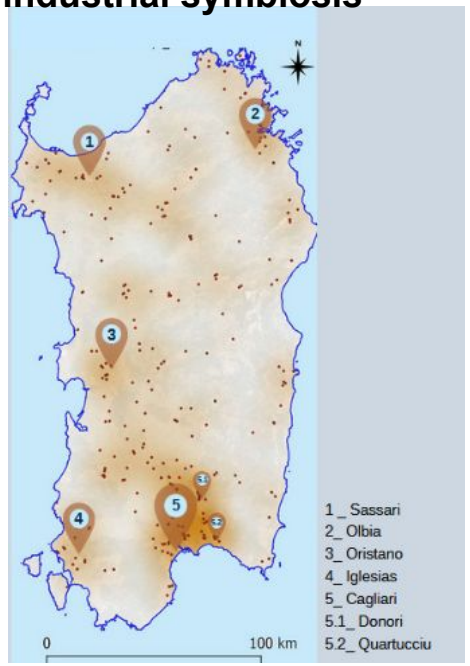








industrial symbiosis



https://circulareconomy.europa.eu/platform/en/dialogue/existing-eu-platforms

7. Conclusion

European Circular Economy Networks / Platforms

ASEAN Circular Economy Stakeholder Platform

The ASEAN Circular Economy Stakeholder Platform (ASEAN CE Platform) is a regional facility helping Association of Southeast Asian Nations Member States achieve sustainable consumption and production by accelerating the transition to a circular economy

Arbeit für Schwaben · IHK Schwaben

The Circular Economy Network of Swabia is organised by the Chamber of Commerce and Industry (CCI) of the Bavarian part of Swabia (Germany). It is open to companies that are members of the CCI. The network organises discussions and the exchange of experiences on circular economy topics.

9 ilhas circulares

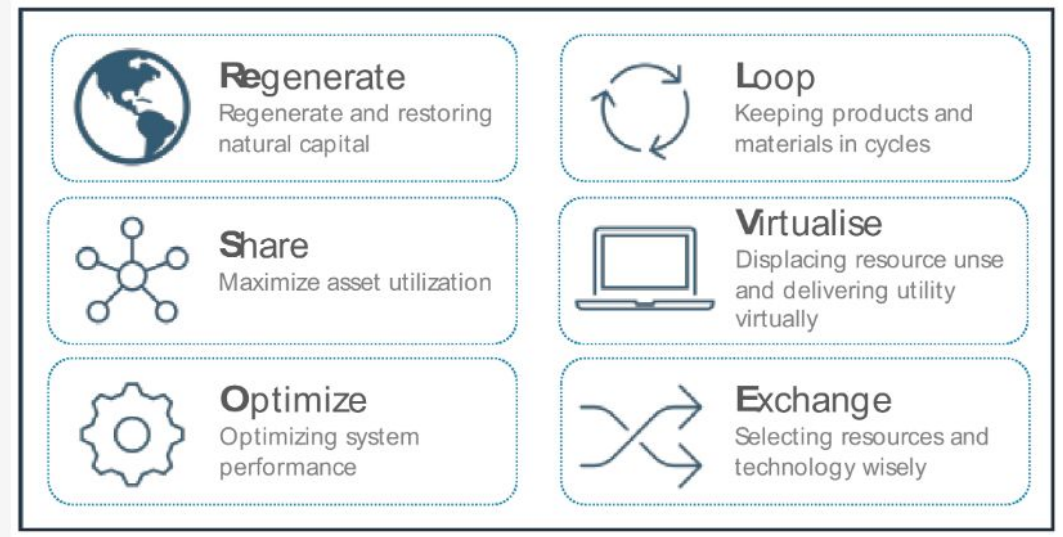
With the 9 Circular Islands (9 Ilhas Circulares) website, the Portuguese public authorities aim to promote a more sustainable lifestyle on the Azores islands.

circular BERLIN

Circular Berlin is an NGO that focuses on making Berlin circular. Berlin is envisioned as a resilient, citizen-oriented region where resources are sourced locally and their value is maintained as part of a continuous loop. Circular Berlin operates across areas such as community-building and education, as well as developing knowledge about industries with a high potential for circularity: the built environment, food and biomass, textiles and fashion, materials and products.

7. Conclusion

The digital transition and the circular economy are two interconnected processes aimed at a more sustainable future. Digital technologies can optimize resource management, reduce waste, and promote material regeneration, aligning production and consumption models with the principles of the circular economy. Together, they can accelerate decarbonization and foster a more resilient and inclusive economy.



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