

Optimize. Improve the performance and efficiency of products; remove waste from their supply chains; and leverage big data, automation, and remote sensing. None of these actions requires changing products or technologies.

Loop. Keep components and materials in closed loops and prioritize the inner ones. For finite materials, this means remanufacturing products or components and (as a last resort) recycling materials, as Michelin, Rolls-Royce, and Renault are doing. For renewable materials, it involves anaerobic digestion and the extraction of biochemicals from organic waste. In the United Kingdom, 146 anaerobic-digestion plants treat 66 percent of sewage sludge, and an additional 175 plants produce bioenergy from solid waste—a number that is growing rapidly.

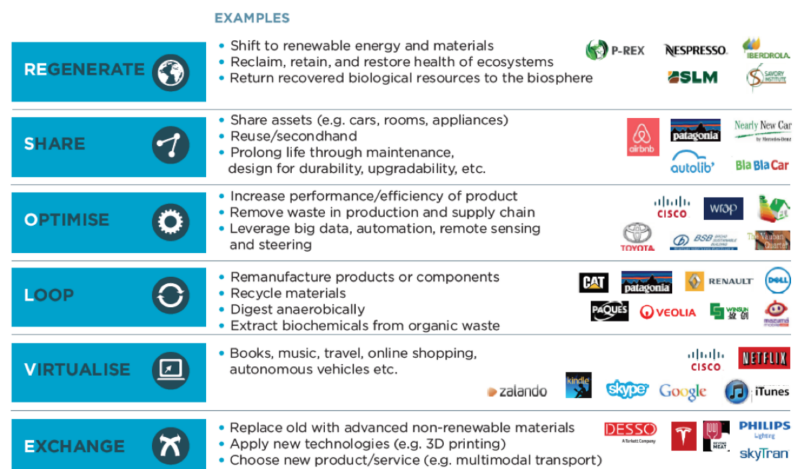
Virtualise. Deliver utility virtually—books or music, online shopping, fleets of autonomous vehicles, and virtual offices.

Exchange. Replace old materials with advanced renewable ones; apply new technologies, such as 3-D printing and electric engines. In different ways, these actions all increase the utilization of physical assets, prolong their life spans, and shift the use of resources from finite to renewable ones. Moreover, each action reinforces and accelerates the performance of the others. Separately and together, they could have a profound impact, increasing cost competitiveness substantially. Most industries already have profitable opportunities in each area. Not all of the technological advances will reduce costs; many might improve performance instead, and in some cases, the technology will need time to make a difference. But the analysis is persuasive: the circular economy carries a transformational potential that business—and society—would do well to take seriously. Main reasoning presented in Fig 9.

ReSOLVE Framework

- Regenerate
- Share
- Optimise
- Loop
- Virtualise
- Exchange

FIGURE 10 THE RESOLVE FRAMEWORK



Source: Company interviews; Web search. S. Heck and M. Rogers, *Resource revolution: How to capture the biggest business opportunity in a century*, 2014.

Figure 9. ReSOLVE Framework, McKinsey

While Fig 10 depicts some useful aspects of the ReSOLVE Framework in reality.

top-down change [/təp- doun, CHän/] noun Top-down change is institution-driven change, such as strategy and policy decisions including public-private partnership projects that are concerned with developing and facilitating market initiatives. ³³		bot-tom-up change [/ˈbädəm- doun, CHän/] noun Bottom-up change can describe social movements and social innovation, such as initiatives and entrepreneurial activities initiated and run by civil society, NGOs, communities and businesses. ³⁴	
Principle	Definition	Top-Down Example	Bottom-Up Example
Regenerate	The shift to renewable energy and materials—to reclaim, retain, and restore the health of ecosystems and return recovered biological resources to the biosphere.	Utilizing rooftops as solar fields, developing green space for biodiversity and to improve air quality.	Personal acquisition of renewable energy; solar panels, urban farming, electric or biogas-fuelled mobility.
Share	Sharing assets (e.g., cars, rooms, appliances), and prolong the life of materials through maintenance, design for durability, upgradability and encouraging reuse/ second-hand.	Policy innovation to support the collaborative economy, regulate sharing, tax and fiscal measures incentivizing sharing.	Car sharing, appliance sharing (washing machines, tools), repair (repair cafes), reuse (clothing, furniture, vehicles, appliances)
Optimize	Increase performance/ efficiency of a product, remove waste in production and supply chain, and leverage big data.	By using gathered data on traffic flows, the efficiency of cities' major transportation can be optimized, decreasing congestion. Installing smart LED lighting throughout the city to save energy. Retrofitting old buildings to increase their energy efficiency.	Smart citizen labs, Fab Labs, smart grids, smart communities.
Loop	Remanufacturing products or components; resources are processed, looped around and put back into the economy, rather than lost in a landfill.	Waste separation and recycling, district heating, bio-based economy, reverse logistics.	Community recycling initiatives, upcycling initiatives, community bio-digesters.
Virtualize	Dematerializing directly and indirectly (for example: e-readers replacing physical books, or a Netflix subscription replacing material DVDs).	Virtual city hall counters. Autonomous public transportation and semi- private transportation like taxis. Virtualization of public libraries, archives, legal information. A paperless municipality.	Community-led digital platforms, citizen-science climate monitoring.
Exchange	The process of replacing old technologies with advanced non-renewable materials, applying new technologies (such as 3D printing) and choosing new products/services.	Circular construction /demolition materials and processes, electric powered public transportation, procurement of circular office furniture.	Electric mobility, organic and locally sourced (super) markets, eco-fashion, e-readers

Figure 10. ReSOLVE Framework¹² examples

¹² <https://guides.co/g/circular-economy-65746/176021>

In diverse domains, specific strategic, tactical, operational approaches are needed to deploy circularity not just to new, but even harder to achieve, to existing businesses and business models. After analysing the construction industry, food industry and fashion industry, the authors Van Cauwenberghe et al., 2023, suggest a helicopter view of the circular production chain from an expanded perspective (Fig 11)

The authors wish to make clear that a “CPC is the result of co-creation and collaboration of multiple parties in a business ecosystem. In the center is the business itself, with its production chain. Here the new material flow goes from the business’s own waste toward its own resources. This is the micro level as explained above, which also encompasses the implementation of the input, design, and output. The first layer outside of the business is the sector the business operates in. These are the companies that in the end aim to fulfil the same needs. On this (meso) level, there are two input flows: products from other companies (#1) and waste from other companies within the same sector, which functions as a resource to the production chain (#2). The latter is a flow which is introduced by the CE paradigm. It can come from both up (pork by-products) and down (demolition waste) the supply chain. There are also two output flows visible: one where the product of the internal production chain flows toward the next business (#12). The other circular flow converts the waste from the production chain into resources for a different business in the same sector (#10) and is an addition by CE.

The next layer is the economy as a whole. It encompasses the economic world outside the sector that our company is part of. This is thus the macro level, yet the connections between the company and other economic agents manifest themselves on the meso level. Here we see a circular approach introduces waste flows from both businesses (#2) and consumers (#3) to the resources of the production chain. Some companies produce the end products of a sector; these flow directly toward the consumer without any more alterations to the product (#13). The consumers of these products are located outside the sector because they are who the sector aims to please. In this layer, there are two waste flows originating from the production chain. One is toward the resource of a business (#10); once again this is a new addition to

the CE paradigm. The other is toward a landfill that we consider part of the economy as a whole (#11). This last flow is one that CE aims to cancel out or at least minimize.

Outside this last layer sits the Earth. This is also the macro level, but because it encompasses more than just the economy, we make a division here. Since CE (and especially the model of Pearce and Turner) aims to close the loop on our whole planet and not just within a company, sector, or the economy itself. In CE, we consider natural resources to be more than just economic assets. They are the positive and negative externalities we hope to internalize through the introduction of CE. They thus reach further than the economy as a whole. The waste produced in the production chain can either flow directly toward the natural resources or through the landfill (#11). Either way they are flows CE considers to be less than desirable. Indeed, whether or not this waste has a negative effect on the natural resources depends on the proportion of waste compared to the assimilative capacity. Ultimately, the aim of CE is to only keep the waste flow smaller than the assimilative capacity. This would then lead to zero waste in the big picture, even if individual production chains still produce waste. Because the assimilative capacity can only be measured on the macro level, measuring whether or not the waste is under or above the assimilative capacity can also only be done on the macro level. Finally, the last flow in the model is the one that represents the use of virgin resources in the production chain (#4). These resources can be exhaustible or renewable. When they are exhausted, they will always have a negative effect on the natural resources, because the harvest is always bigger than the yield. The effect of renewable resources can be negative or positive depending on the harvest to yield ratio (Pearce & Turner, 1990). CE promotes the use of renewable resources whose harvest is smaller than the yield. Nonetheless, CE still aims to limit the use of virgin resources. Much like the assimilative capacity the yield and harvest of a resource can only be measured on the macro level. Note that we placed the three forces mentioned earlier in this outer sphere. All three of them influence the production chain through the different layers and are influenced by them.” (Van Cauwenberghe et al., 2023)

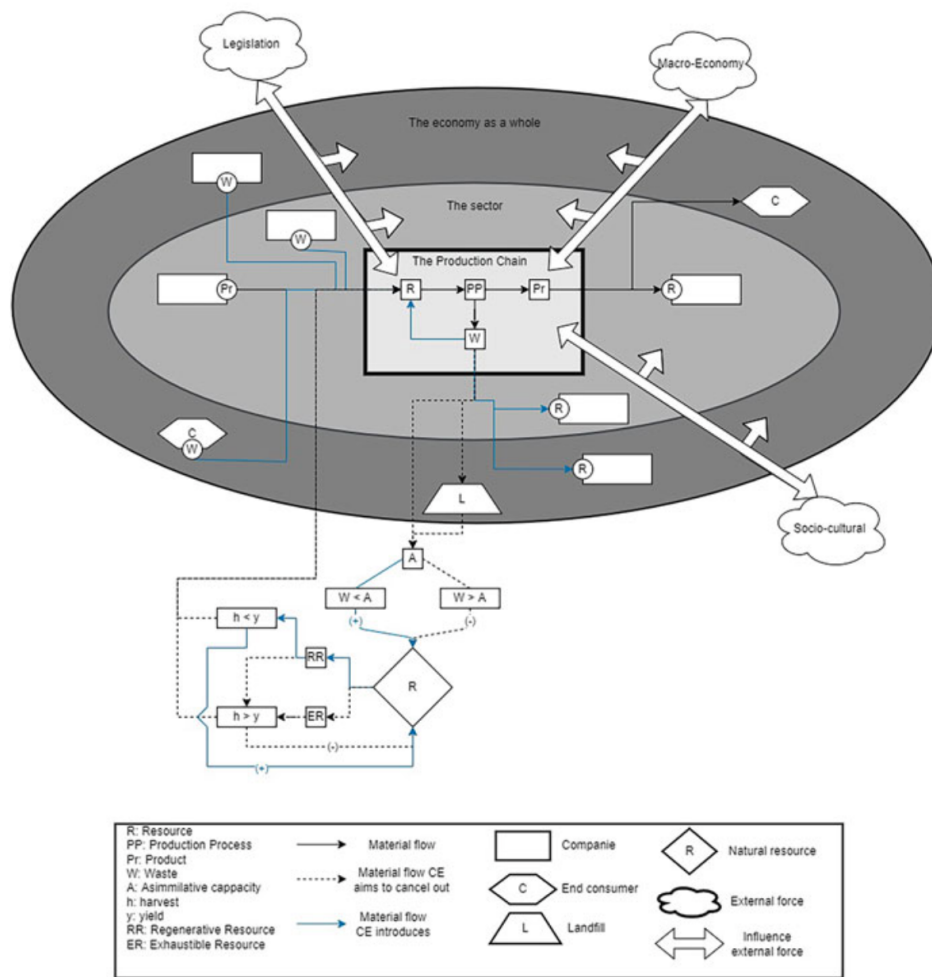


Figure 11. Circular production chain (CPC) from extended perspective (Van Cauwenberghe et al., 2023)

Furthermore, using the Denica managerial method¹³, Hendrickx visualised the circularity mechanism across an entire business ecosystem, in order to portray the necessary system perspective needed for any governance to be able to deploy circularity. While fig 12 visualises the generic business ecosystem, fig 13 considers big picture view as well as internal decomposition of roles and accountabilities, to be able to portray the circular process.

¹³ <https://link.springer.com/book/10.1007/978-3-030-22804-0>

A system of roles and accountabilities across the broad business ecosystem

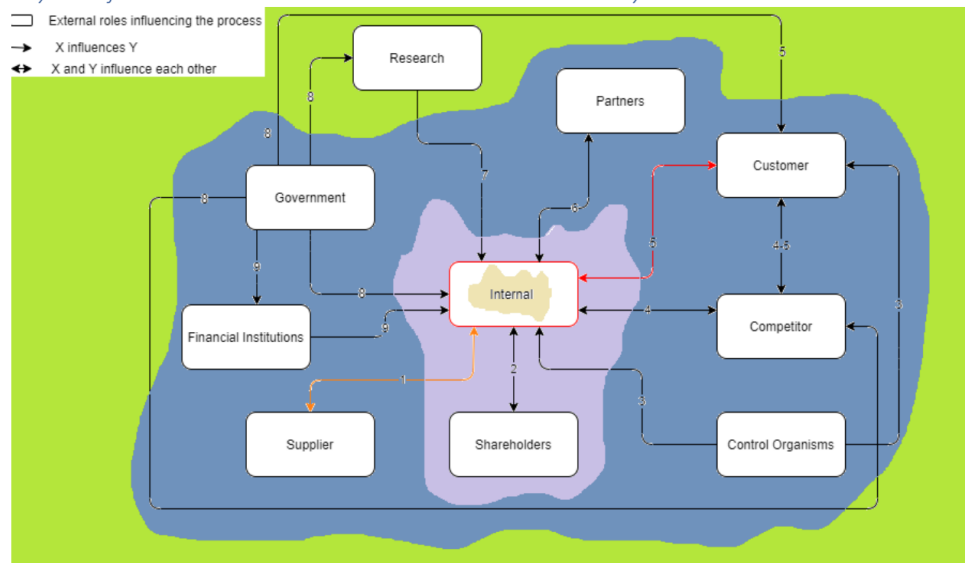


Figure 12. System of roles and accountabilities across the broad business ecosystem, using the Denica managerial method, Hendrickx 2020

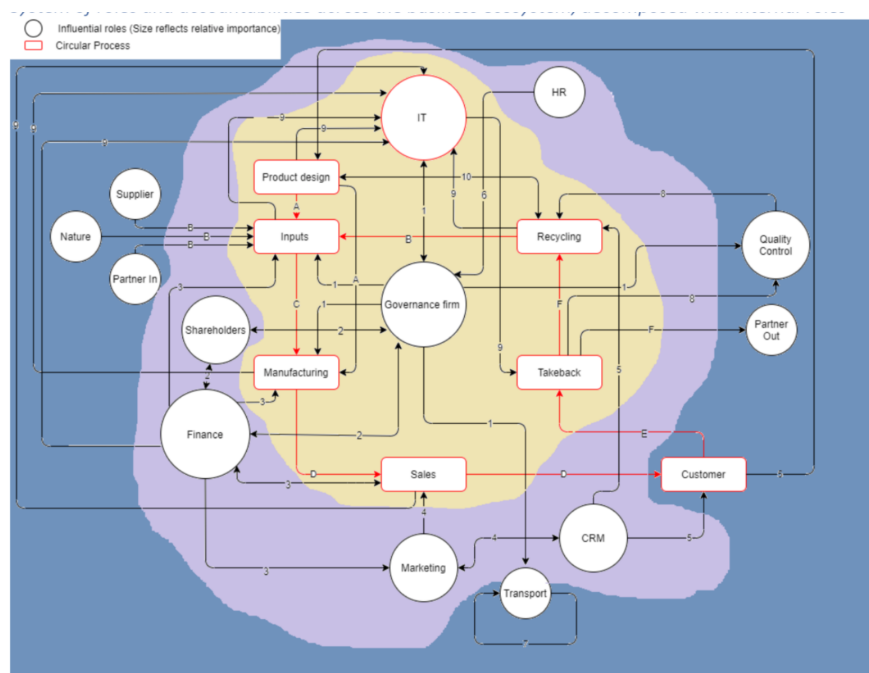


Figure 13. System of roles and accountabilities across the broad business ecosystem, decomposed with internal roles and components to portray the

circular process (red line), using the Denica managerial method, Hendrickx 2020

05. Business models and Entrepreneurship

A **business model** is the conceptual representation of an enterprise (Teece, 2010). It embodies the raison d'être of the organization and outlines how the enterprise will create, capture, and deliver value to its customers (Osterwalder & Pigneur, 2010; Rosa et al., 2019; Teece, 2010).

Nowadays, there is an abundance of business models, both traditional and more contemporary.

Among the traditional, contemporary and hybrid business models, we can enlist:

- Direct sales (retail, producer - seller, distributor network, services)
- Subscription (marketplaces and discounts)
- Franchising (business multiplication on various locations with usage of the brand name)
- Marketing (fixed price or percentage of sales)
- Strapping (cheap basic product and expensive replaceable parts, conditional purchase, gifts)
- Pay per use (fixed amount plus payment for used goods/services)
- Brokerage (charging after the goods are sold)

- Anything as a service (enabling use of anything and charge per its use - not ownership or purchase)
- Freemium (free version plus paid services in premium)
- Shared assets (investment in ownership of goods which can be used by multiple customers)
- Leasing (of equipment, vehicles)
- Reselling (collection and aggregation of goods, waste, ...)
- Agents (connecting different businesses across the circular net)
- Hybrid combination of different models

The most practical one-sheet model for the business logic, helpful both for entrepreneurs and theorists, is the Business Model Canvas (Osterwalder & Pigneur, 2010), which encompasses the following components (De Gussemé, 2021).

Value proposition

Every working business model has a specific offer towards the customer to satisfy their needs and solve their problems. This offer can be seen as a collection of products and services that fulfil the needs of a particular customer segment. The value proposition of business models varies from very innovative offers to existing market offers with slightly different features. The value proposition can be qualitative (e.g. brand, customisation, design, performance) or quantitative (e.g. cost reduction, price, risk mitigation) (Lewandowski, 2016; Osterwalder & Pigneur, 2010).

Customer segments

Most businesses are not able to serve all customers in the market. Defining and targeting a particular customer segment is essential for a successful business model. Customers can be divided into small or large groups based on everyday needs, behaviour, or other characteristics. Once the segments are defined, based on their specific characteristics, certain distribution channels must reach them, particular relationships must be held, profitability will vary, and their willingness to pay can differ. Examples of different types of customer segments are mass market, niche market, segmented market (slightly different needs), and diversified market (very different needs) (Osterwalder & Pigneur, 2010).

Channels

How to communicate the organisations' value proposition to the customer? Business models' channels are an essential tool to enhance customer experience. Channels have 5 phases through which the customer can be influenced (to raise awareness, help with evaluation, convince to purchase, deliver the value, and after-sales support). Communication can be done by owned or partner channels and direct or indirect (Lewandowski, 2016; Osterwalder & Pigneur, 2010).

Customer relationships

What kind of relationship to hold with customers? The different relationships can range from personal to automated and driven by customer acquisition, retention, or cross/upselling. Examples are personal assistance, self-service, automated services, or co-creation (Osterwalder & Pigneur, 2010).

Revenue streams

Without generating revenue, a business cannot survive. Revenue streams occur when the value proposition of the company is successfully delivered to the customer. There are two types of revenue streams: transaction revenues from

one-time payments or recurring revenues from ongoing payments (Lewandowski, 2016; Osterwalder & Pigneur, 2010). Examples are asset sale, usage fee, subscription fees, licensing, and advertising. Each revenue stream can have a particular pricing mechanism. The main pricing mechanisms are fixed menu pricing (e.g. volume dependent) and dynamic pricing (e.g. bargaining) (Osterwalder & Pigneur, 2010).

Key resources

To create and offer a value proposition, every enterprise needs assets. Key resources are essential assets that, besides those mentioned above, help reach markets, generate revenue, and hold relationships with customers. They can be divided into four categories: physical, financial, intellectual, or human (Osterwalder & Pigneur, 2010).

Key activities

Several key activities need to be performed to operate a company successfully. Like key resources, key activities are necessary to offer a value proposition, help reach markets, generate revenue, and hold relationships with customers. They can be divided into the following categories: production, problem-solving (e.g. consultancy, hospitals), and platform (Osterwalder & Pigneur, 2010).

Key partnerships

Key partners can be defined as a network of suppliers and partners necessary to operate a business model successfully. There are several reasons to create partnerships: economy of scale, to reduce risk and uncertainty, and to acquire resources and activities. Partnerships can be divided into four categories, i.e., strategic alliances (between non-competitors), coopetition (between competitors), joint ventures, and buyer-supplier relationships (Lewandowski, 2016; Osterwalder & Pigneur, 2010).

Incurring costs when running a business is unavoidable. It is necessary to create and deliver a value proposition, reach markets, generate revenue, and hold relationships with customers. Every company wants to minimise costs as much as possible, but some are more sensitive to costs than others. Following that, we can identify two main classes of cost structures: cost-driven and value-driven. Examples of features of cost structures are fixed costs, variable costs, economies of scale, economies of scope (Osterwalder & Pigneur, 2010).

Designed for:

Designed by:

Date:

Version:

The Business Model Canvas

Key Partners Who are our key Partners? Who are our key suppliers? Which Key Resources do we acquire from partners? Which Key Activities do partners perform? KEY PARTNER BENEFITS: Acquisition and economies Reduction of fixed and variable costs Acquisition of particular resources and activities	Key Activities What Key Activities do our Value Propositions require? Our Distribution Channels? Customer Relationships? Revenue streams? KEY ACTIVITIES: Production Platform Development Distribution Network	Value Propositions What value do we deliver to the customer? Which one of our customers' problems are we helping to solve? What bundles of products and services are we offering to each Customer Segment? Which Customer needs are we satisfying? VALUE PROPOSITIONS: Performance Customization Convenience Design ("the look and feel") Price Risk Reduction Self-Service Accessibility Compatibility/Interactivity	Customer Relationships What type of relationship does each of our Customer Segments expect us to establish and maintain with them? Which ones have we established? How are we managing along with the rest of our competitors? How costly are they? CHANNELS: Channels (intermediaries) Distribution Sales Channels Partners Co-optation	Customer Segments For whom are we creating value? Who are our most important customers? NEW SEGMENTS: New Markets New Customer Segments New Channels New Products New Value Propositions
	Key Resources What Key Resources do our Value Propositions require? Our Distribution Channels? Customer Relationships? Revenue Streams? KEY RESOURCES: Human (know people, expertise, idea) Capital Physical		Channels Through which Channels do our Customer Segments want to be reached? What are we reaching them how? How are our Channels integrated? Which ones work best? Which ones do most cost efficient? How are we integrating them with customer routines? CHANNEL PARTNERS: 1. Distribution 2. Production 3. Acquisition 4. What are we help customers evaluate our organization's value proposition? 5. How do we allow customers to purchase specific products and services? 6. Delivery 7. How do we establish a value Proposition to customers? 8. After sales 9. What are possible post-purchase customer support?	
Cost Structure What are the most important costs elements in our business model? Which Key Resources are most expensive? Which Key Activities are most expensive? IN YOUR BUSINESS CASE: Fixed Costs (salaries, rent, utilities) Variable Costs (materials, shipping, advertising) Start-up Costs (equipment, inventory, legal fees) Overhead Costs (rent, utilities, insurance, etc.) Marketing Costs (advertising, promotion, etc.)	Revenue Streams For what value do our Customers really willing to pay? For what do they currently pay? For what do they currently pay? How would they prefer to pay? How much does each Revenue Stream contribute to overall revenues? FIXED COSTS: Fixed Costs (salaries, rent, utilities) Overhead Costs (rent, utilities, insurance, etc.) Marketing Costs (advertising, promotion, etc.) REVENUE STREAMS: Product Revenue (sales) Service Revenue (fees) Licensing Advertising NEW REVENUE: New Products New Services New Markets New Channels New Partners NEW REVENUE: New Products New Services New Markets New Channels New Partners			

DESIGNED BY: Business Model Foundry AG

The makers of Business Model Generation and Strategyzer

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Strategyzer

strategyzer.com

Figure 14. Business Model Canvas, Osterwalder & Pigneur, 2010¹⁴

¹⁴ <http://www.businessmodelgeneration.com/>

06. Circular Business Models

If we would like to move on from the linear economy and generic business models, toward circular economy and circular business models which incorporate in their design the circularity principles, we need to enhance the BMC with several components and accents.

Hence, a **circular business model** is a business model that operates in closed loops where it creates, captures, and delivers value (Antikainen & Valkokari, 2016; Lewandowski, 2016). The business model is based on retaining the value of materials, products, and components after usage and enhancing the regeneration of finite resources within a relevant system boundary (Smith-Gillespie, 2017; Rosa et al., 2019).

Lewandowski, in 2016, after analysing abundance of business models and the circularity principles, suggests addition of at least two components to the business models (Fig 12):

- **“Take-Back system**—the design of the take-back management system including channels and customer relations related to this system
- **Adoption factors**—transition towards circular business model must be supported by various organizational capabilities and external factors”

Partners - Cooperative networks - Types of collaboration	Activities - Optimising performance - Product Design - Lobbying - Remanufacturing, recycling - Technology exchange	Value Proposition - PSS - Circular Product - Virtual service - Incentives for customers in Take-Back System	Customer Relations - Produce on order - Customer vote (design) - Social-marketing strategies and relationships with community partners in Recycling 2.0	Customer Segments Customer types
	Key Resources - Better-performing materials - Regeneration and restoring of natural capital - Virtualization of materials - Retrieved Resources (products, components, materials)		Channels Virtualization	
	Take-Back System - Take-back management - Channels - Customer relations			
Cost Structure - Evaluation criteria - Value of incentives for customers - Guidelines to account the costs of material flow			Revenue Streams - Input-based - Availability-based - Usage-based - Performance-based - Value of retrieved resources	
Adoption Factors - Organizational capabilities - PEST factors				

Figure 15. A framework of the circular business model canvas. Source: adapted from Osterwalder and Pigneur, by Lewandowski, 2016

Within the Live Circular Canvas project¹⁵, there have been very applicable additions made to the BMC in direction of CE, which are used also along with this handbook/manual. Namely, within the Market value proposition, there are two additional aspects:

- **Social value** - the value to be provided for the society
- **Planet value** - the value to be provided for the planet

While, the existence of the:

- **Take-Back system** - in direction of 'whose output is my input' and 'where does my input go' and

¹⁵ <https://livecircularcanvas.eu/en>

- **Adoption factors** - inner and external factors

Is visible and useful for comprehensive circular business models (Fig 16)

 Co-funded by the Erasmus+ Programme of the European Union		CBMC SE03 Villa Nygammalt		
Key Partners  We buy our new products from wholesale companies.	Key Activities  Trendy design. An "eye" for what is worth restoring, repairing and repainting the furniture. Running the shop For the old furniture, people sometimes offer to sell some furniture and we also visit auctions and look for items on the internet	Market Value Proposition  We re-furbish, re-design and re-paint old furniture. Besides the restored and repainted furniture, we also offer a wide range of new products for home decoration	Customer Relationships  At the shop face-to-face. Activity on Facebook, good relations with our customers. A well-known name in the region	Customer Segments  Customers that want to make a difference and are conscientious about the environment. People from other parts of Sweden that have summer houses in the area, that they want to decorate in a certain style
	Key Resources  Old furniture Paint. New fabric.	Social Value  One more shop that will help attract customers to our small town.	Channels  Direct: Shop sales Communication: Social media, Facebook	
		Planet Value  To re-use and prolong the lifetime of old furniture is always good for the planet	Take-Back System 	
Costs  The main costs are: buying old furniture, costs for rent and salaries More variable than fixed costs(75 – 25%)	Revenue Streams  100% Base Sales of the shop Re-designing and re-storing old furniture take a lot of time and work. Limited profit			
Adoption Factors 	INNER Factors Organization (HR):			
	EXTERNAL Factors PEST (SOCIAL): the customers are aware of our planet value contribution and take extra pleasure in buying furniture that is re-used. People might feel good when they buy second-hand products instead of cheap IKEA-products that often come from low-wage countries.			

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Figure 16. Circular Business Model Canvas, Live Circular Canvas project

On the issue of **managerial guidelines for CE BM and entrepreneurship**, we are suggesting the following (Sanders, 2022) (Fig 17)

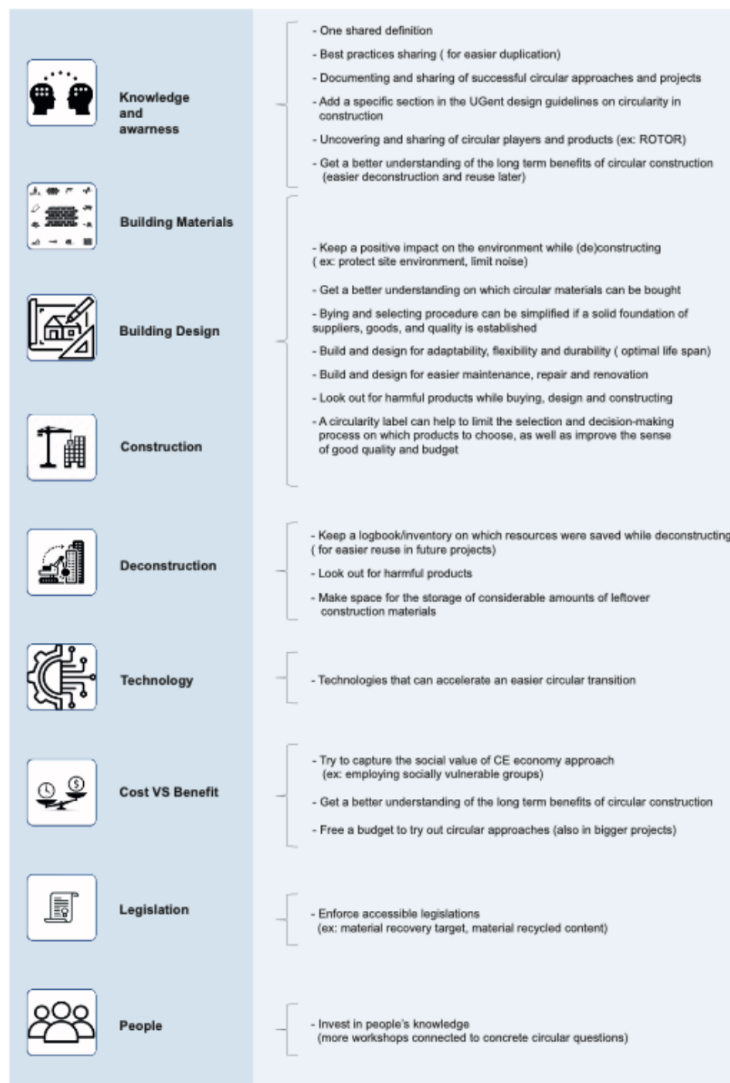


Figure 30: IVAGO's adaptive loop for GFT container collection

Figure 17. Managerial perspective on Circular Economy guidelines (Sanders, 2022), and IVAGO's adaptive loop for GFT container collection (Lebeeuw, 2020)

Part B - Circular Practices in Diverse Contexts

07. Global Practices

Out of numerous global practices and best practices in the spirit of CE, we are placing here several, as presented in the research work of De Koninck, 2020.

The Omni processor¹⁶

The Omni processor is a machine built and engineered by Janicki Bioenergy in Seattle; the project is funded by the famous Bill & Melinda Gates Foundation. The original function of the omni processor consisted of physical, biological and chemical processing fecal sludge. Liquid waste dumping is a big problem in developing countries, the waste contaminates the drinking for many people, this can lead to diseases and to physically and mentally underdevelopment (Gatesnotes, 2019).

The processors' principal activity is the excluding of pathogens and make sure to halt the spreading of fecal sludge diseases but at the same time to generate outputs that contain a commercial value (Kuchenrither et al., 2012). The rest products of the sludge processing consist of energy, clean drinking water and soil nutrients, these products have the potential to create revenues (Gatesnotes, 2019). Despite all these benefits, the most interesting and innovative aspect of this processor is the fact that it is not only capable of processing human sludge but also waste water. This is very useful in the journey of providing clean drinking water from treated and polluted water

¹⁶ <https://www.gatesnotes.com/Development/Omni-Processor-Update>

The Automated Vacuum Waste Collection system¹⁷

The automatic vacuum waste collection system invented and produced by Envac AB, a Swedish company. The system relies on an underground system of pipes, where garbage is automatically sorted and recycled or burned for energy. It's a sustainable garbage-removal system which excludes street-corner trash or garbage pick-up trucks. Regardless of the location, the vacuum system can be used everywhere. The goal is to make cities cleaner, greener and more attractive, but the most important aspect is the reduced amount of waste associated with traffic, which leads to significantly lower carbon emissions. After waste collection through the pipes, waste is further automatically separated with a smart recycle system (Arrabal et al., 2015; Hidalgo et al., 2018; Envac, 2019)

The waste bins can be located strategically wherever suits best considering the placement (e.g. hospital vs. a smart city). One big change considering the prevailing waste collection system are the operating hours. The automated vacuum system is working 24/7 which means that this system gets rid of bulging bins due to its automatic working and independency of human workforce (Hidalgo et al., 2018). The system can be installed outside or inside, considering the preferences and location of placement. (Envac, 2019)

Winnow¹⁸

Winnow is a company founded by Marc Zornes and Kevin Duffy. Marc, a former McKinsey worker set up Winnow. Winnow is a software as a service company. The system is based on groundbreaking artificial intelligence and aims to run kitchens where food waste is cut in half. In their latest product, Winnow Vision, kitchens only need to throw away food. The bin will capture the waste on camera, recognize it and thereafter calculate by weight. The smart bin "learns" to recognize all types of foods, so the smart system knows exactly what and how much you are putting in your kitchen bins and thus how much actually has been wasted.. Up to a one third of all food that is produced

¹⁷ <https://www.actenviro.com/glossary/automated-vacuum-waste-collection-system/>

¹⁸ <https://www.winnowsolutions.com/>

in the world is lost or wasted, with an estimated value of 1 trillion USD discarded each year. Furthermore, greenhouse gas emanating from decomposition of post-consumer organic waste is responsible for 5% of global emissions (FAO, 2018). As David Jackson, head of marketing in Winnow stated; “if food waste was a country, it would be world’s 3rd largest greenhouse emitter” (Mekhjian et al., 2017; Altariba et al., 2017)

The focus of Winnow is kitchens within the hospitality industry, who have had a difficult time in recent years due to competition of new businesses as UberEats and Deliveroo which is leading to lower profits. This is where Winnow comes in, offering a simple and novel technology package that helps commercial kitchens manage their food resources in a smarter way. Within the first year of operation food profits will increase with 30-60% and food waste will decrease with 40-75%. The slogan of Winnow: “Unlock the value of food waste in your kitchen” aims to a more profitable and sustainable commercial kitchen in the hospitality industry. On 26th November (2019) Winnow reached a total saving of \$ 33.000.000, 23. 202.500 Meals were saved and 42.000 tonnes of CO2 was saved (Winnow, 2019).

The Interceptor¹⁹

The Ocean Cleanup, founded by Boyan Slat, develops technologies to get rid with the world’s oceans of plastic. Except from cleaning up the current trash in the sea, the inflow of new river plastic needs to be addressed. Research by the Ocean Cleanup concluded that only 1000 rivers are responsible for 80% of ocean plastic entering the oceans, which makes rivers the main source of ocean plastic pollution.

As a solution to this problem, the Interceptor was invented, a system to clean up river flows to the sea. The interceptor works as follows; first, the interceptor takes a strategically position in the river and debris flows into the system because the barrier is directing waste to the mouth of the interceptor. The barriers covers only half of the river so it will not interfere with other vessels or impede the movement of wildlife. Next a conveyor belt extracts the

¹⁹ <https://theoceancleanup.com/rivers/>

debris from the water onto a giant shuttle, this system functions autonomously, using smart software, the shuttle knows when to equally distribute waste into one of the six dumpsters until they reached a similar amount of trash. At any time, local and global operators can remotely access the interceptor's dashboards from anywhere in the world. Once full, the interceptor automatically sends a text message to the local operators to come and collect the waste. Operators then remove the barge, and it is brought back to shore, where the dumpsters are emptied, send off the debris to local waste management facilities, and return the barge back into the Interceptor. The Interceptor can store up a maximum of 50m³ of trash before needing to be emptied, so at top performance, the interceptor can extract more than 100.000 kilograms of trash per day. This means it's capable of operating even in the most polluted rivers all over the world (The Ocean Cleanup, 2019).

DyeOx²⁰

The textile industry is big business, in india it is worth a \$2.64 billion. But despite the many economic benefits to the textile industry cities, the benefits come together with enormous environmental and social drawbacks. The “dyeing part” in a textile industry is a major producer of hazardous waste and at the same time large amounts of fresh water are used during this process (Agrawal, 2015). And to make it even worse, most of that untreated wastewater is discharged as toxic effluents which eventually leads to contamination. Soils, water surfaces and mainly rivers are polluted, subsequently rivers will bring the toxics to the sea, where it can further spread to every ocean in the world. DyeCoo has found a solution for the giant pollution caused by the major textile industry (DyeCoo, 2019).

The DyeOx4 machine is the latest technology invented and manufactured by DyeCoo. The machines' process consists of dyeing cloth while using not one drop of water or chemicals, besides in the dyes themselves. The technology is using heated and highly pressurized carbon dioxide as a dyeing medium, at that phase the CO₂ can act a solute and solvent at the same time. This is resulting

²⁰ <https://dyecoo.com/the-dyeox/>

in very quick penetration of the color pigments into the textile fibers without any extra needs. In this process, the cloth does not need to be dried, which cuts the processing time in half, uses less energy and eliminates costs. At the end, the carbon dioxide is recycled and used again, and so a fully closed loop is created. This new efficient technique can make the textile industry cleaner and more profitable at the same time (Agrawal, 2015; Van Der Kraan, 2017; DyeCoo, 2019).

MycoComposite²¹

MycoComposite is a platform that uses mycelium to bind together organic agricultural byproducts, such as wood chips, to produce durable, bio-based and 100% compostable material. The company Ecovative is responsible for developing this alternative styrofoam. In our natural system we find mycelium as the natural adhesive that holds the forest floor together. Mycelium can be used as main substitute for polystyrene, the main component in plastic which is made from petroleum and is a non-sustainable, non-renewable, hyper polluting and fast disappearing commodity. It is not biodegradable and ends up into landfills, while the mushroom based packaging will decompose in a garden in a couple of weeks. The production of the mushroom packaging is very easy and relies on a natural system. First clean agricultural waste is inoculated with mycelium, thereafter mycelium does the work, Over a few days the fungus binds the waste together forming a solid shape. The great thing about mycelium is you can grow it into every mold as you like and it will fit exactly. At last the mycelium package needs to be dried to prevent the fungi from growing. In fact mycelium is used as a natural glue. To use of mycelium as packaging is promising and compatible with our planet as it decreases waste, increases recycling and prevent plastic (Dahmen, 2017; Kim & Ruedy, 2019; Ecovative, 2019).

²¹ <https://www.ecovative.com/pages/mycocomposite>

Micronized Rubber Powder (MRP) by Lehigh Technologies²²

About one billion tires are discarded worldwide, annually. Using post-industrial raw rubber materials and post-industrial rubber materials end-of-life tires to generate renewable raw materials for industrial applications (fa. high-performance tyres, coatings, asphalt and construction material) can end this enormous rubber waste and satisfy the rising global demand from governments, manufacturers and consumers for more sustainable products (Habibah et al., 2018; LeHigh Technologies, 2019).

Lehigh Technologies has succeeded in this and is creating a more sustainable rubber industry, they manufacture high-performance, lower cost, sustainable Micronized Rubber Powders (hereafter MRP) from rubber materials. Lehigh has commercialized a proprietary cryogenic turbo mill technology that transforms end-of-life tire and post-industrial rubber materials into MRPs, the company is dedicated to developing high value uses for end-of-life tire materials that would otherwise be burned or deposited in landfills. Lehigh provides a sustainable solution to the important environmental problem of end-of-life tires and other post industrial rubber material by transforming waste materials into high-value products, they succeeded to close the loop by using these rubber particles over and over again (Habibah et al., 2018; LeHigh Technologies, 2019; Michelin, 2018).

Renewable Food for Animals and Plants²³

More than 30% of organic waste, such as food containing loads of nutrients, is wasted daily, mostly sent to landfills creating toxic greenhouse gases that are harming our environment. At the same time there is a growing demand for high quality protein in the animal feed and aquaculture sectors. Currently this aquaculture feed is produced in a way that depends on finite resources, and leads to environmental degradation. Black soldier fly (hereafter BSF) larvae provide a valuable solution to this global problem, as they naturally upcycle nutrients from organic matter. For over a hundred million years fly species have

²² https://lehightechnologies.com/what_we_do/what_is_micronized_rubber_powder/

²³ https://www.rcbc.ca/files/u7/RCBC2015_EnterraLeung.pdf

been breaking down organic material, whilst providing food for fish, birds and animals in our nature. This is the essence of how we use black soldier flies to transform discarded organic matter to high quality protein feed for the fish, poultry and other industries. At Enterra, traceable, recycled food including fruits, vegetables and grains are used to feed our insects. The Canadian company is diverting food waste from landfills and the flies are converting it to high quality nutrients for animal feed, pet food, oils and organic fertilizer. After eating the waste, the bugs are cooked and dried (which kills the insects and any pathogens inside BSF), they are pressed for oil and the remaining solids converted into a powdery meal. This environmental friendly approach makes sure that nothing is wasted and everything is gained. Likewise, the operation requires no water as all the water the insects need comes from the recycled fruits and vegetables in their diet. Black soldier fly larvae are a highly efficient, low-impact source of nutrients compared to resource-intensive alternatives like beef, pork, chicken, fishmeal, soymeal, coconut oil and palm kernel oil and non-organic fertilizers (Enterra, 2019).

The author's analysis and placement of the Business Model components within the Butterfly Diagram and the ReSOLVE Framework, has resulted with grading them as in Fig 18.

P = ReSOLVE element present in the CBMC of the particular waste management solution.

	Regene rate	Share	Optimise	Loop	Virtualize	Exchang e	Total
The Omni processor	p	p	p	p		p	5/6
Automated Vacuum waste collection system	p		p	p		p	4/6
Winnow	p	p	p		p	p	5/6
The Interceptor	p	p	p	p		p	3/6
DyeOx	p	p	p	p		p	5/6
Mycocomposite	p	p	p	p	p	p	5/6
Micronized Rubber Powder	p	p	p	p	p	p	5/6
Renewable Food for Animals and Plants	p		p	p		p	4/6

Table 4: Summary of the fit of the investigated approaches to Circular Economy principles of the ReSOLVE framework.

Figure 18. Analyzed global best practices and their placement within the CE frameworks, De Koninck, 2020

08. BECircular project best practices

Within the BeCircular project, a best practice has been used, to improve and co-evolve the region's situation with waste management and in general, circular business models. The main carriers for this knowledge have been DIADYMA S.A.²⁴ - Responsible Body for Waste Management in Western Macedonia, Greece and CluBE²⁵ - Bioeconomy and Environmental Cluster in Western Macedonia, Greece.

Integrated Waste Management Solution - Diadyma

Diadyma's main objective is the "Design, implementation and operation of the Integrated Waste Management Plan in Western Macedonia Region" (IWMS) and has been unfolding in stages since its founding in 1998, through

²⁴ <https://diadyma.gr/en/>

²⁵ <https://club.e.gr/en/>

present times and with remarkable ambitions and plans for the upcoming decades. Its application of sustainable waste management methods objectives of National and European legislation (at lowest cost for the citizen) follows the Directive 2008/98/EC on waste (Waste Framework Directive)²⁶ and the relevant European regulations.

The evolution of IWMS of Western Macedonia, has gone through the following phases:

- 1st Phase: Ensure Landfill and restoration of Uncontrolled Dumpsites (2003-2007)

Restoration of 207 Uncontrolled dumpsites (38 with funding of 6 million € from Operational program ‘Environment and sustainable development’ (EPPERAA), 169 with funding of 3 million € from program THISEAS “Development Program for Local Government) (Fig 19)

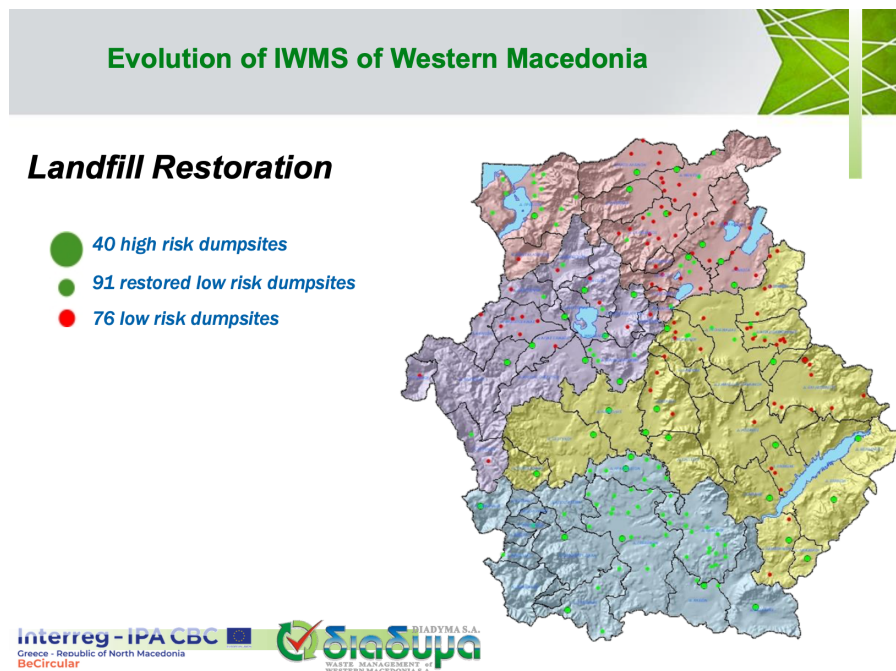


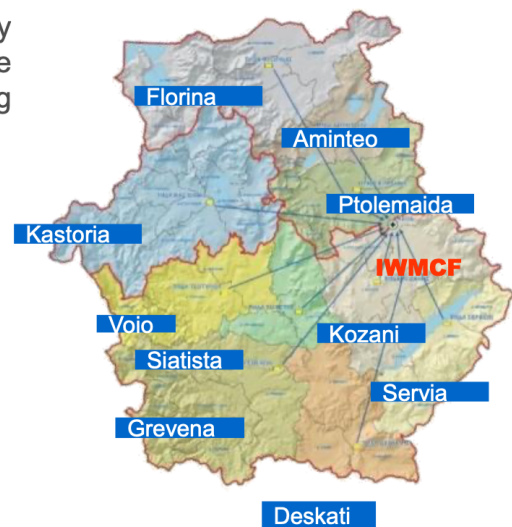
Figure 19. Landfill Restoration, DIADYMA S.A., Greece

²⁶ <https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32008L0098>

Evolution of IWMS of Western Macedonia

1st Phase: Ensure Landfill and restoration of Uncontrolled Dumpsites (2003-2007)

- Construction of 9 LWMU, 1 Regional Sanitary landfill (A & B Cells), Supplies of mobile equipment for waste transfer and land filling (Cohesion Fund, 13 million €)



Interreg - IPA CBC
Greece - Republic of North Macedonia
BeCircular



Figure 20. Regional Sanitary Landfill and 9 LWMUs, DIADYMA S.A., Greece

The comprehensive facility for waste management incorporates managerial, technological, logistical, organisational and environmental aspects and represents a next level solution for waste management. (Fig 21)



Figure 21. Facility for the IWMS, DIADYMA S.A., Greece

- The **2nd Phase** consisted of: **Development of Recycling with Collection at Source programs & Exploitation of waste with the MBT plant (2009-2015)**

Development of Collection at Source programmes with the use of four different bins (each for different recyclable material) (ESPA 4 million €, Hellenic recovery recycling corporation 1,5 million €)

Construction of C' cell of sanitary landfill and Supplementary mobile equipment (ESPA 10 million €)

Signing of Contract for the construction of MBT plant - through PPP project
Total Investment 48 million €) – Beginning of Construction (01-07- 2015)

- The **3rd Phase: Prevention and Reuse** (2016- 2020)

Green Points Network for reuse and exploitation

- Urban type “Green Points” in specific settlements(<3.000 inhabitants)
- Collection of items for reuse in Materials Reuse Centers (logistics centers)
(Fig 22)
- Networking of facilities – Online access for citizens (e-platforms)



Figure 22. Reuse Centers, DIADYMA S.A., Greece

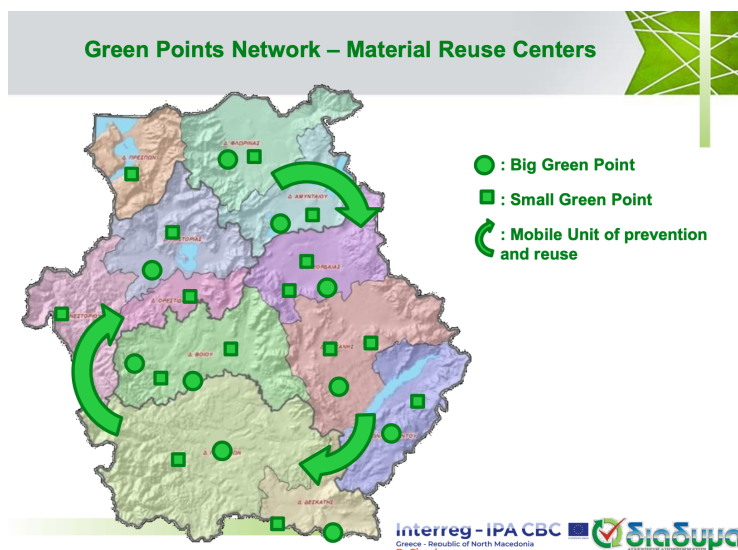


Figure 23. Green Points, DIADYMA S.A., Greece

- The **4th Phase: Towards a Circular Economy** (2020 -) encompasses plans and actions to achieve:

Circular Economy Park

Complex of Treatment and Utilization Units of special categories of non-hazardous waste of Municipal Solid Waste (MSW)

Complex of Hazardous Waste Classification, Storage and Treatment Units contained in Municipal Solid Waste (MSW)

Circular and Innovation Center

The circularity achieved in the IWMS of Diadyma is portrayed on the following visual they provided us for this handbook (Fig 24, Fig 25):

Which fits perfectly within the Butterfly diagram and the ReSOLVE framework of the CE.

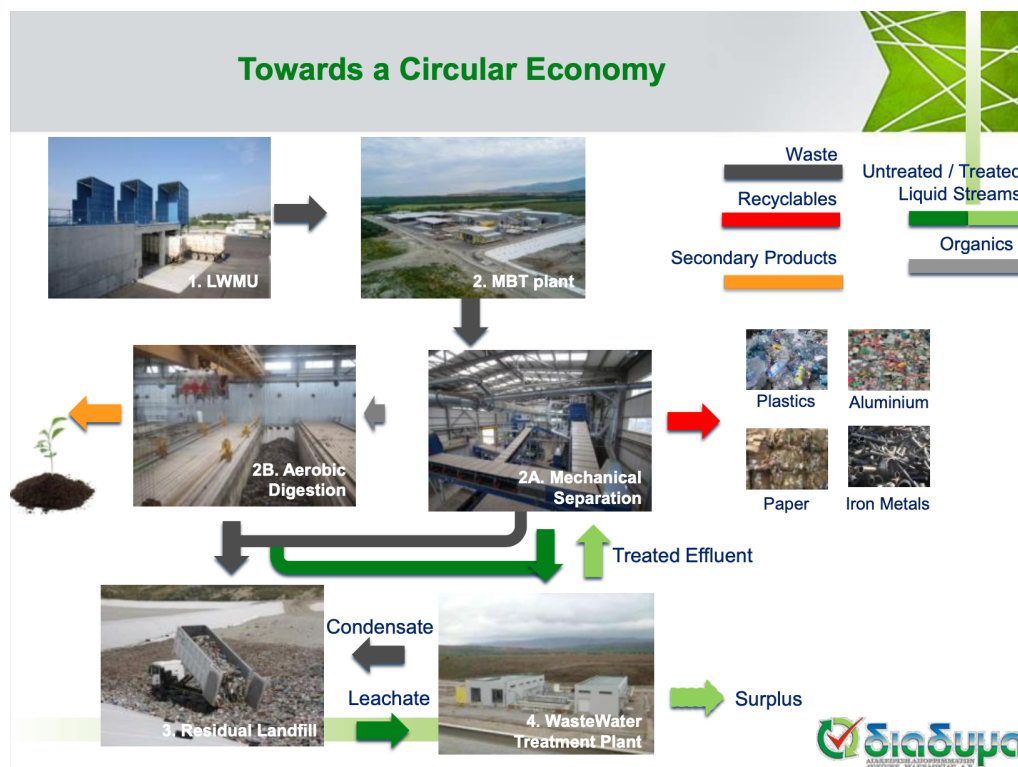


Figure 24. Circular workflow, DIADYMA S.A., Greece



Figure 25. Recyclable materials circular workflow, DIADYMA S.A., Greece

Bioeconomy and Environment Cluster – CluBE

Another best practice to learn from is the specific cluster approach for undertaking projects, especially in CE, where the stakeholder ecosystem is broad, the motivations are diverse, the socio-environmental-technological aspects are all intertwined with some (but not exclusive) business and project logic.

“The Cluster of Bioeconomy and Environment of Western Macedonia (CLuBE) is a platform for cooperation of the three pillars of the regional economy: the public sector, research and entrepreneurship. The Cluster seeks to develop synergies between local and regional players and businesses in bioenergy and the environment, aiming at introducing and developing innovation in the sector and increasing its added value.”²⁷ Such a cluster operates since 2014 as not-for-profit company, in diversity of sectors, such as: BIOENERGY, ENVIRONMENT, ENERGY SAVING, BIOMASS, SUPPLY CHAINS, BIOGAS, BIOECONOMY, SMART CITIES, BIOHYDROGEN, which necessitate multi/trans/cross/interdisciplinarity, n-tuple helix co-creation, bottom-up approaches and strategic/tactical/operational altitude of collaboration and remarkable vision and adaptation, to achieve the change management by engagement and facilitation of all necessary agents.

Some of the challenges being addressed in CLuBE’s specific manner, are towards the energy sector and agriculture (Fig 26 and Fig 27) which are directly relevant for cross-border learning and knowledge transfer, since the North Macedonia side also faces the same difficulties and challenges.

²⁷ <https://clube.gr/en/>