



BUSINESS ECOSYSTEM ENABLING IWM AND CIRCULAR ECONOMY MODELS

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The union for the Mediterranean supports the development and implementation of this project within the 2030 GreenerMed Agenda

About *BUSINESSMED*:

BUSINESSMED is the main regional representative of the Private Sector

that reflects the interest of 25 Confederations of Enterprises from States members of the Union for the Mediterranean - UfM.

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In collaboration with our Members and Partners, our vision of the Mediterranean is one where

- The business ecosystem across the two shores flourish via strong partnerships, and establishment of regional value chains

- Economic development is accompanied by a strong and inclusive social dialogue where different social partners collectively shape

the business ecosystem of the Mediterranean Countries

- Mediterranean Partners collectively and comprehensively address upcoming challenges of the region, building on each other strength to establish a balanced and flourishing business ecosystem

About the expert :

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Dr. Samia DHAHRI obtained a PhD (CNRS- Center National de Recherche Scientifique, University Montpellier 2, France) in 2013, after a Master's degree (INPL -Institut National Polytechnique de Lorraine, France) and an engineering degree (INSAT-National Institute of Applied Sciences and Technology-, Tunisia /- Claude Bernard Lyon 1 University, France) obtained in 2009.

She also has a certificate in patent drafting from the WIPO (World Intellectual Property Organization) and trained in entrepreneurship and skills development in India, management of incubators in Egypt, etc. Since 2018, she is responsible of a Technology Transfer Office and is a founding executive member of a network of African Union incubators and participates in various international projects.



Foreword

At BUSINESSMED, we understand the importance of sustainable waste management practices and their impact on the environment, the economy, and society as a whole.

This report is a testament to our commitment to promoting sustainable business practices in the Mediterranean region. By analyzing the current state of waste management and circular economy models in these countries, we aim to provide valuable insights and recommendations to policymakers and businesses on how to create more sustainable and efficient waste management systems.

We believe that this report will serve as a valuable resource for our organization and the wider community, as it highlights the importance of waste management and its impact on the environment and the economy. By promoting sustainable waste management practices, we can create a more prosperous and sustainable future for the Mediterranean region.

At BUSINESSMED, we are committed to working with our partners, stakeholders, and members to promote sustainable business practices and create a more sustainable and prosperous future for all. We believe that this report will be a valuable contribution to our ongoing efforts to promote sustainable development in the Mediterranean region.

BUSINESSMED

Med4Waste

Med4Waste project is a capitalisation project funded by the ENI CBC MED programme on the priority of waste management.

Recent research highlights the worrying environmental effects of current production and consumption patterns in the Mediterranean Sea Basin, further accelerated by climate change impacts exerted by land-use (urbanization, agricultural intensification), pollution and declining biodiversity. In such context, Med4Waste project aims to facilitate new governance models for integrated and efficient urban waste management policies across the Mediterranean strategy. The project lays on a strong and experienced partnership composed by 7 organisations from 6 Mediterranean countries and reinforced by 3 pools of associated partners and supporters from the whole basin. Moreover, it encompasses up to 8 activities oriented at building skills, planning and decision-making

capabilities for Mediterranean institutions from public and private sector, and based on the most successful practices previously implemented in the region. Consequently, decision policy-makers will find a platform to promote better governance in the sustainable use of resources and management of waste, moving towards more sustainable patterns of consumption and production at Mediterranean level, whilst developing joint and common policy responses.

The Union for the Mediterranean (UfM) supports the development and implementation of this project within the 2030 GreenerMed Agenda. UfM provides regular policy and technical advice and facilitates the integration, coordination and upscaling of the main project activities and outcomes within the relevant UfM Policy Frameworks and beyond, maximising the dissemination of results among UfM countries and stakeholders at Euro-Mediterranean level.

Countries: Greece, Italy, Jordan Lebanon, Spain, Tunisia

Partners :



GENERAL OVERVIEW

Financed by European Union under the ENI-CBC Med Program, MED4WASTE (Mediterranean Dialogue for Waste Management Governance) is a project which aims to facilitate new governance models for integrated and efficient urban Waste Management (WM) policies across the Mediterranean, with particular emphasis on organic waste and Circular Economy (CE).

This report, on business ecosystem enabling Waste Management and circular economy models in Mediterranean countries (Greece, Italy, Jordan, Lebanon, Spain and Tunisia), falls within the framework of MED4WASTE project and will focus on analyzing the concepts of resource-efficient and climate-friendly waste management systems. We will investigate how integrated circular economy solutions are incorporated into national and regional policy processes, and how business cooperation programs are developed.

Information and data collected, in cited countries, will be analyzed in order to map various regulations, initiatives and opportunities for future entrepreneurs.

The report will include potential of green jobs and propose integrated circular economy solutions in line with national and Mediterranean political regulations.

INTRODUCTION

The exceptional economic and technological development achieved in recent years has been accompanied by high rates of resource consumption and negative impact on the urban environment. Generation of wastes, in Mediterranean countries, is far beyond the handling capacities of urban government and agencies. Despite several management strategies implemented, urban waste management remains a massive concern for Mediterranean countries.

The criticality of the problem can be evaluated from the fact that Solid Waste Management (SWM) is crosscutting issue that can be directly linked to twelve out of seventeen UN Sustainable Development Goals (SDGs) (Rodić and Wilson, 2017). There is an increasing awareness that effective WM is essential for transitioning towards a Circular Economy (CE) and

achieving SDGs (Villalba Ferreira et al., 2022). Indeed, great efforts will have to be made at national and regional level to deal with problems of high volumes of waste, the disposal technologies and the impact on environment.

Also, its essential to consider the informal sector in Mediterranean countries for sustainable waste management, since it has been demonstrated that significant economic and environmental benefits can be realized by leveraging the natural strengths of this informal sector (Kala, Bolia, and Sushil, 2022).

Figure 1: Urban waste on the Mediterranean coast



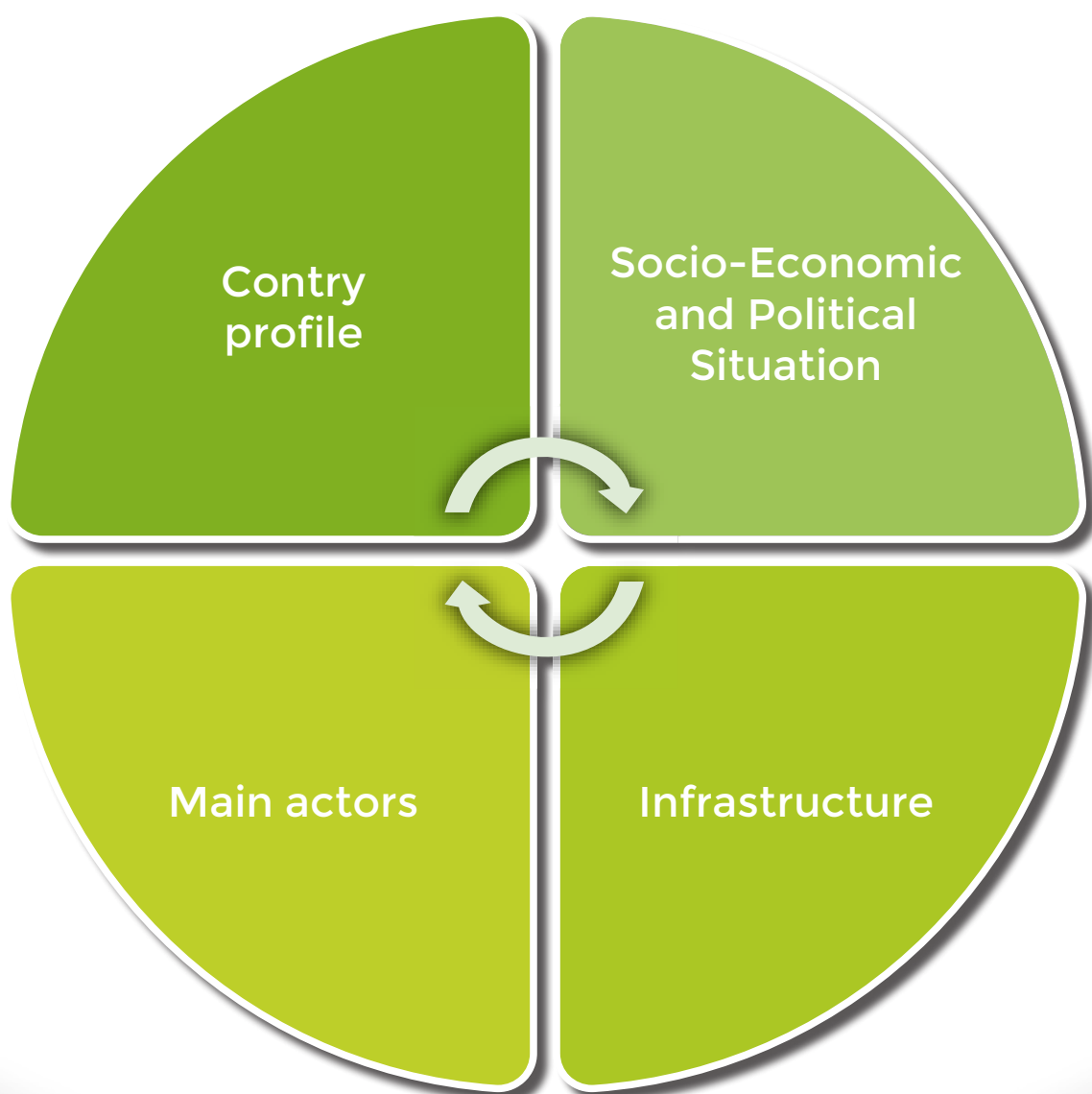
MOTIVATION AND OBJECTIVES

The urban waste management problems provide a window of opportunity for Mediterranean cities to find innovative solutions. MED4WASTE aims to changes practices and methods so that human development is not accompanied by environmental degradation.

Through investigating business ecosystem enabling IMWM and CE economy, this report aims to build and improve existing knowledge to foster capitalization of social, innovative, integrated and efficient practices from public, private and social sectors in waste management across the Mediterranean Sea Basin (MSB).

Also, through chapter dedicated to future challenges and goals, and policy recommendations, this report will try to offer guidance for public administrations and relevant private and social stakeholders, to apply transferring actions and exploitations measures and to support planning, adapting and re-addressing of WM plans policies and other management actions and normative drivers. This report, which covers seven Mediterranean countries, will foster long-term commitment of decision and policy makers at regional level, promoting an environmental, socio-economic and institutional transition towards green growth in the MSB. The report aims to help Mediterranean region adopt more sustainable consumption to address common challenges in environment.

1. WASTE MANAGEMENT ECOSYSTEM IN MEDITERRANEAN COUNTRIES



1.1. TUNISA



1.1.1. Country profile

Population	12,458 (2023) 70% littoral
Surface area	163. 610 km ²
Municipal Solid Waste Generation	2.825 million tons (68 % organic fraction, 9;4 % plastic, 8.6% paper, 1.6% Metal, 17.2 % other) 55 000 tons (packaging)
Per Capita MSW Generation	0.6-0.8 Kg/day
Collection rate of MSW	Urban areas: 80% Rural areas: 10 %

1.1.2. Socio-economic and political situation

During last decades, Tunisia has experienced demographic development, that has led to a strong urban growth that resulted in an increase in the quantity of waste produced. At the same time, Tunisia's economic performance decelerated after the 2011 revolution, due to political instability, resulting in a lost decade of growth, exacerbated by the COVID-19 pandemic, which hit in 2020.

A significant decline in productivity growth was observed, GDP growth declined to 1.7 percent on average between 2011 and 2019, as a result of excessive regulation of economic activity, reduced trade orientation, low investment, and limited innovation. (Worldbank, 2022)

Figure 2: Character representing informal waste collectors



This evolution associated with political instability lead to the absence of rigorous mechanisms for quantification and characterization of waste. The growing waste crisis has given rise to unrest and social tensions, such as in the governorate of Sfax in southern Tunisia. As a result of the closure of the nearby Agareb landfill, which triggered a crisis in the country's-controlled landfills, trash went uncollected; some 30,000 tons of waste piled up in Sfax's streets. This case has highlighted the urgent need to address waste management and the broader environmental situation in Tunisia, considering its implications for both the climate and residents' health.

1.1.3. *Waste Management Situation*

Solid waste management has emerged as a big challenge in Tunisia. The available data are estimates carried out within the framework academic studies, that remain very approximate. The country, having an estimated population of around 12 million people, produces more than 2.8 million tons of waste each year. The production of waste has the particularity to varies according to the seasons and the days of markets. This volume increases +25% in summer for less touristy areas and up to 50% in tourist towns especially by the sea. More generally, Tunisia is experiencing an average increase in waste volume by 3% with per capita waste generation in urban areas adding up to more than 2.5 million tons each year.

Biodegradable organic fraction constitutes around 68% of the MSW stream. Many municipal landfills do not meet sanitary standards: Tunisia's largest, Borj Chakir, the Tu-

nis area's only controlled dump, takes in an estimated 3,000 tons of solid waste per day — well over the 44 tons per day permitted in EU landfills. At present, only 4-7% of Tunisia's waste is recycled. The recycling sector is currently driven almost exclusively by informal waste collectors known as “barbechas”, their number is around 8000. They go through trash containers and landfills and remove recyclable items without having any official legal status to do so.



Figure 3: a-b: Informal waste collectors in Tunisia

1.1.4. Main actors ¹

Governmental actors	<ul style="list-style-type: none"> • Ministry of Industry and Small and Medium Enterprises • Ministry of Local Affairs and Environment • Ministry of Public Health • Ministry of Agriculture • Ministry of the Interior • Municipalities • ANGED (National Waste Management Agency) • ANME (National Agency for Energy Management) • ANPE (National Environmental Protection Agency) • APAL (Coastal Protection and Planning Agency) • CITET (International Center for Environmental Technologies of Tunis) • Technical centers (CTAA, CTC, CETTEX, CETIME, etc.) • ONAS (National Sanitation Office)
Private sectors	<ul style="list-style-type: none"> • Non-hazardous waste management companies ² • Hazardous waste management companies³
Associations & NGOs	<ul style="list-style-type: none"> • Association Tunisienne pour la Sensibilisation et l'Edu- cation à l'Environnement (ATSEE) • Association pour la Protection de l'Environnement et le Développement Durable (APEDED) • Tunisian Association for the Management and Valorisa- tion of Solid Waste (AGORA) • Tunisian Zero Waste Collective • Tunisian associations ("Association for the Protection of the Environment and Sustainable Development of Bizerte" -APEDDUB, "Citizenship and Sustainable Development"-Gabes, "Tunisie Recyclage", etc.) • WWF (World Wildlife Fund), Tunisia • United Nations Development Programme (UNDP) • United Nations Industrial Development Organization (UNIDO)
Academia	<ul style="list-style-type: none"> • National Institute of Marine Sciences and Technologies (INSTM) • Higher Institute of Environmental Science and Tech- nology, Borj Cedria • Waster Research and Technologies Center (CERTE) • National Institute for Research and Physico-Chemical Analysis (INRAP) • Centre of Biotechnology, Sfax (CBS) • Centre of Biotechnology, Borj Cedria (CBBC) • Ecole Nationale d'Ingénieurs de Tunis (ENIT) • Institut National Agronomique de Tunisie (INAT) • Université de Tunis El Manar

¹ This list is not exhaustive, and there may be other organizations involved in waste management.
² http://www.anged.nat.tn/Decembre_2022_Liste_des_societes_ayant_des_cahiers_des_charges_dechets_non_dangereux.html
³ http://www.anged.nat.tn/Fevrier_2022Liste_societes_autorisees_dechets_dangereux.html

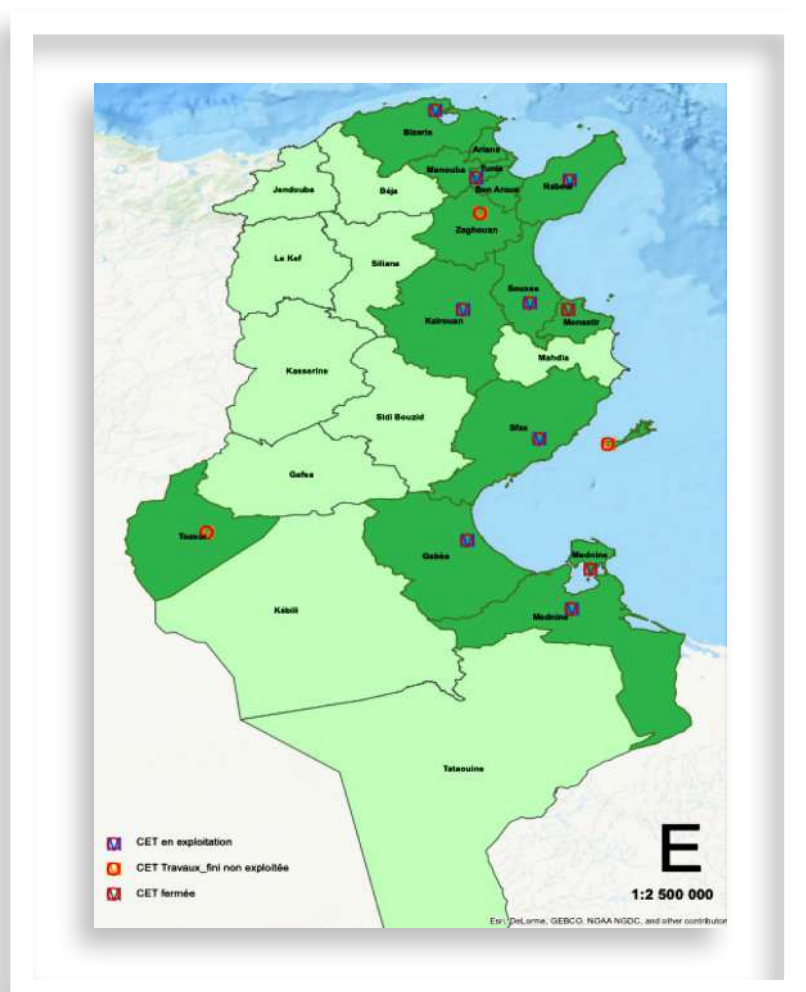
1.1.2. Infrastructure

- Controlled landfills or technical landfill center (CET): 13.
- Transfer centers: 55.
- Infrastructure costs: 100 Million TND.

MSW collection is covered at 80% in urban areas and 10% in rural areas. The country has 10 controlled landfills with a capacity of 1,788,000 tons per year and four other semi-controlled landfills in the Valley Medjerda with a capacity of 62,000 tons per year. Five other discharges with a nominal capacity of 0.466 million tons per year are being built and finally five other controlled discharges are planned with an average capacity of 0.433 million tons per year. However, many municipal landfills do not meet sanitary standards and waste is often dumped into non-sanitary areas. Interestingly, only five percent of MSW is composted and merely 4% recycled. The expenditure for

waste collection and transport constitutes 75-100% of the total solid waste management budget.

Figure 4: The quantities of waste treated at all controlled landfills currently in operation in Tunisia (ANGED, 2018)



1.2. Lebanon



1.2.1. Country profile

Population	6. 825 Million (2020)
Surface area	10. 452 km ²
Municipal Solid Waste Generation	2 million tons
Per Capita MSW Generation	1.05 Kg/day
Collection rate of MSW	Urban areas: 100% Rural areas: 99 %

1.2.2. Socio-economic and political situation

Lebanon faces today an economic and financial crisis ranked among the most severe in the world:

- GDP fell from 55 billion (2018) to below 20 billion (2021)
- Public debt/ GDP : over 150%
- Poverty and unemployment: over 50 % & 30 %
- Currency depreciation : 95% LBP value vs USD
- Significant budget and trade deficits
- Recession : -14% in 2019

Covid 19 pandemic reduced economic activity and layoffs. Beirut port blast: August 4th 2020 caused over 200 deaths, 7000 injuries and 15 billion dollar in property damage. The Spring 2021 Lebanon Economic Monitor found that Lebanon's economic and financial crisis ranks among the worst economic crises globally since the mid-nineteenth century. For nearly three years, Lebanon has been assailed by the most devastating, multi-pronged crisis in its modern history. The unfolding economic and financial crisis

that started in October 2019 has been further exacerbated by the dual economic impact of the COVID-19 outbreak, and the massive Port of Beirut explosion in August 2020. Of the three crises, the economic crisis has had by far the largest (and most persistent) negative impact.

The protracted economic contraction has led to a marked decline in disposable income. GDP per capita dropped by 36.5% between 2019 and 2021, and Lebanon was reclassified by the World Bank as a lower-middle income country, down from upper middle-income status in July 2022. Such a brutal contraction is usually associated with conflicts or wars. Beyond the human tragedy, the impact of the Port of Beirut explosion has had implications at the national level, despite its geographical concentration. These add to Lebanon's long-term structural vulnerabilities, which include low-grade infrastructure—a dysfunctional electricity sector, water supply shortages, and inadequate solid waste and

wastewater management—as well as weak public financial management, large macro-economic imbalances, and deteriorating social indicators.

1.2.3. Waste Management situation

Solid Waste management has become of increasing concern ; although the privatization of this sector in terms of collection and treatment, a significant number of communities and municipalities are still facing major problems with the treatment and disposal of waste, hence directly affecting the environment and creating serious economic and social problems. Corruption, lack of human resources and suitable facilities and inadequate technical skills are responsible for inefficient municipal solid waste management (Abbas et al., 2019). Since 1994, Lebanon's waste management policy has consisted of implementing a series of emergency plans, each partially and poorly executed, and extended until a new crisis emerged. Devoid of any measures to move to long-

term, sustainable planning, these local emergency fixes to the lingering waste crisis have incurred high financial costs for citizens as well as negative environmental, health, and safety impacts.

Lebanese citizens are paying a high price for solid waste management (SWM). Lebanon spends \$154.5 to manage every ton of solid waste, compared to Algeria, Jordan, and Syria which spend \$7.22, \$22.8, and \$21.55, respectively (Human Rights Watch, 2020). The

solid waste sector ranked first in terms of environment-related government spending in Lebanon, with a total of \$647 million spent between 1998 and 2008 (Arif & Doumani, 2014). Expenditures on SWM reached \$2.2 billion between 1996 and 2015 (Akiki, 2019).

Despite these high expenditures, the cost of environmental degradation (COED) from the solid waste sector was around \$66.5 million (0.2% of national GDP) in 2012 (Arif & Doumani, 2014), increasing

Figure 5: Garbage crisis in the streets of Beirut



to \$200 million (0.4% of GDP) in 2018 (MoE, UNDP, 2019). To date, around 20% of the waste is recovered, out of which only 6% reaches recycling facilities, 36% is landfilled, and 44% is dumped in around 940 open dumps scattered throughout the country (MoE, UNDP, UNHCR, UNICEF, 2020).

At the same time, this situation represented an opportunity for several WM companies. A private company contracted since 1994 to collect and treat much of Lebanon's waste – Sukleen (part of the Averda Group) – has generated over \$170 million

in revenues per year, one of the highest waste management revenues in the world (Chaaban, 2016). Sukleen has held a monopoly in waste management in Beirut and Mount Lebanon since the 1990s, when it won a contract for building, testing, and operating a waste incinerator located in the city

of Amrousiyeh. Operation at that site was short-lived as angry residents burned the plant down in 1996, but through other contracts, Sukleen came to handle around 50% of the waste generated nationally, serving around 400 municipalities (Chaaban, 2016). The company's contract was renewed three times by the Council for



Figure 6: Garbage crisis in Lebanon

Development and Reconstruction (CDR) without an open tender. With each contract renewal, collection and processing fees increased, all paid using transfers from the Independent Municipal Fund, an intergovernmental grant system that disburses taxes and fees to municipalities.

1.2.4. Main actors

Governmental actors	<ul style="list-style-type: none"> • Ministry of Environment • Ministry of Health • Ministry of Industry • Ministry of Interior and Municipalities • Municipalities
Private sectors	<ul style="list-style-type: none"> • Companies of Waste Management (Batco, etc.) • Waste collection and street cleaning: “Sukleen” “Lavajet”, “Batco” • Waste treatment and disposal: “Sukomi”
Associations & NGOs	<ul style="list-style-type: none"> • Agency for Technical Cooperation and Development (ACTED) • DRI • Sustain the World • Berytech • Live Love Recycle • Society for the Protection of Nature, Lebanon Clean & Green, Green Line Association, Lebanese Association for Energy Saving and for Environment (ALMEE), Association for Forests , Development & Conservation, Green Peace-Lebanon, Friends of Nature, etc. • Young Men’s Christian Association (NGO) • United Nations Development Programme (UNDP) • Arc-en-ciel • Lebanon Waste Management • IndyACT • Waste Management Coalition (WMC)
Academia	<ul style="list-style-type: none"> • Faculty of Science, Beirut, Lebanese University • École Supérieure d’Ingénieurs de Beyrouth (ESIB)- Saint Joseph University • Faculty of engineering III - Lebanese University • Issam Fares Institute - Climate Change and the Environment , • American University of Beirut • Maroun Semaan Faculty of Engineering and Architecture- American University of Beirut

1.2.5. Infrastructure

48 % of the waste are disposed in sanitary landfills.

Outside the capital Beirut and Mount Lebanon, dumping of waste and open burning is predominant.

1.3. Spain



1.3.1. Country profile

Population	47. 35 Million (2022)
Surface area	505. 990 km²
Municipal Solid Waste Generation	22,438 thousand tons
Per Capita MSW Generation	476 Kg/year (2019)

1.3.2. Socio-economic and political situation

Spain has been in the midst of a balanced economic recovery in recent years; however, the COVID-19 crisis led the country into an unprecedented downturn in economic activity in 2020, with the deepest contraction among EU member states. Spain's public finances deteriorated swiftly as a consequence of the COVID-19 pandemic and of the measures taken to contain its impact: in 2021, the general government deficit stood at 5.1% of GDP.

Nevertheless, despite the fact that containment measures still in force dragged down the economy in the first half

of 2021, Spain's GDP is estimated to have grown 5.7% over the year (IMF), with tourism-related activities supporting the recovery and private demand as the main growth driver. Spain is set to continue growing in 2022 (6.4%) and to return to its pre-pandemic level by the beginning of 2023. The EU Recovery and Resilience Plan (RRP) is expected to boost both public and private investment, as household consumption should remain strong over the forecast period.

Existing short-time work schemes were reinforced to offset the COVID-19 crisis; however, the pandemic widened inequalities in the labour market, with disruptions among

young, low-skilled, and temporary workers being particularly harsh. Nevertheless, both the number of workers and the unemployment rate have roughly recovered to their pre-pandemic levels. The latter stood at 15.4% in 2021 but is expected to decline to 13.9% in 2023. Spain remains a country with strong inequalities: according to the latest data by the Spanish Statistical Office, 26.4% of the population was at risk of poverty or social exclusion in 2020, up by more than 620,000 individuals in one year as a repercussion of the pandemic-induced crisis.

1.3.3. Waste Management situation

Generation of waste in Spain has increased in parallel with economic growth, as in other European countries. In recent years, government, economic sectors and society have become more aware of the issue, waste treatment infrastructure has increased, and a solid business sector specializing in waste management has emerged.

According to data compiled by the Spanish National Institute of Statistics (INE), Spanish industry generated 49.9 million tonnes of waste in 2008 (13.9 % less than the previous year). Manufacturing industry generated 19.4 million tonnes, mining and quarrying 25.7 million and energy generation accounted for the remaining 4.9 million tonnes. A high percentage of the waste generated in Spain is still disposed of in landfill sites. In this regard, work is under way to reduce waste generation, encourage re-use, implement separate collection of differentiated waste, and decrease the amount of waste disposed of in landfill sites.

Management of household waste is the responsibility of local authorities and is performed to guidelines by the regional governments of Spain's autonomous communities. The challenge facing government is to implement efficient and effective management models that ensure compliance with the legal obligations and aims of the entire range of regional, national and community waste legislation.

1.3.4. Main actors

Governmental actors	<ul style="list-style-type: none"> • Ministry of Environment and Energy (MITECO) - responsible for environmental policy and waste management in Spain. • Spanish Waste Agency (OAPN) - responsible for implementing waste management policies and programs. • Regional Environmental Agencies - responsible for waste management at the regional level. • Autonomous Communities (ACs) • Municipalities • Commission for the Coordination on Waste (Comisión de Coordinación en materia de residuos)
Private sectors	<ul style="list-style-type: none"> • FCC Medio Ambiente - a Spanish company that provides waste management services, including collection, treatment, and disposal. • Sacyr - a Spanish construction and engineering company that also provides waste management services. • Ecoembes - a non-profit organization that promotes recycling and responsible waste management in Spain. • Lipasam - a waste management company that provides services in Seville. • Urbaser - a Spanish waste management company that provides collection, treatment, and disposal services. • Valoriza Servicios Medioambientales - a company that provides waste management services, including recycling, composting, and waste-to-energy solutions. • Ence Energía y Celulosa - a Spanish company that produces pulp and paper products, and also operates waste-to-energy plants. • Ferrovial Servicios - a Spanish company that provides a range of environmental services, including waste management, recycling, and composting.
Associations & NGOs	<ul style="list-style-type: none"> • Asociación Española de Empresas de Gestión de Residuos y Recursos (ASEGRE) - a Spanish association of companies involved in waste management and resource recovery. • Amigos de la Tierra España / Friends of the Earth Spain - a Spanish NGO that promotes environmental protection and sustainable development, including waste management issues. • Greenpeace España - a Spanish NGO that campaigns for environmental protection, including waste management issues. • Ecologistas en Acción - a Spanish environmental NGO that advocates for sustainable development and environmental protection, including waste management issues. • WWF España • MedCities - A network of Mediterranean cities that work together on sustainable urban development, including waste management.

Academia	<ul style="list-style-type: none"> • Cátedra UNESCO de Ciclo de Vida y Cambio Climático (UNESCO Chair in Life Cycle and Climate Change) • Instituto de Tecnología de Materiales y Energía (Institute of Materials and Energy Technology) - • Instituto de Investigación en Energías Renovables, Medio Ambiente y Desarrollo Sostenible (Institute for Research on Renewable Energy, Environment, and Sustainable Development) -
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1.3.5. Infrastructure

56.7% of waste is dumped in **landfills**, while 43.3% is recycled or reused.

Specifically, 13.5% is used to generate energy, 18.3% is recycled and 11.5% is used for composting and digestion.

1.1.1.

Figure 7: Economy of Spain



1.4. Jordan



1.4.1. Country profile

Population	10.3 Million (2022)
Surface area	89. 342 km ²
Municipal Solid Waste Generation	4 million tons
Per Capita MSW Generation	0.99 Kg/day: urban areas 0.87 Kg/day: rural areas
Collection rate of MSW	Urban areas: 90% Rural areas: 70%

1.4.2. Socio-economic and political situation

Jordan has begun its recovery from the COVID-19 shock — real GDP grew by 2.2% in 2021 following a 1.6% contraction in 2020. However, the COVID-19 crisis has exacerbated Jordan's jobs challenge: Unemployment stood at 23.3% in Q4-2021, youth unemployment reached nearly 50% and the women's labor force participation rate is 14%, one of the lowest in the world. At end-2021, Jordan's public and publicly guaranteed gross debt stood at 113.8% of GDP (and debt net of SSIF debt holdings at 92% of GDP)

respectively. High unemployment rates, widening external imbalances, elevated debt levels and weak investment highlight sizable challenges to a robust recovery.

Jordan also faces several climate-related hazards, including significant temperature increases, precipitation decreases and increased incidents of drought. Jordan is heavily dependent on fossil-fuel imports, with limited natural resources. It is among the most water-poor countries in the world. Jordan's fiscal situation demands that it finds private sector solutions to climate

challenges and that it incentivizes these solutions from a climate lens as part of its development model.

1.4.3. Waste Management situation

Solid Waste Situation in Jordan The SWM sector in Jordan is one of the most complex sectors due to the wide variety of SW types and compositions. Millions of metric tons of MSW are generated in Jordan from agricultural, municipal and industrial sources every year. The growing industrialization and high population growth rate due to the recent forced migration has led to a rapid increase in solid waste generation in the country which has, in turn, put increasing pressure on the existing waste management infrastructure. The current Solid Waste Management (SWM) services within the local municipalities are no longer of the same standard as that prior to the massive influx of refugees and the daily generation rate of MSW has dramatically increased. 350 tons of waste is currently being generated daily in Irbid and Mafrag; which should be collected and hauled away by the municipalities to the relevant final landfill “disposal sites”.

1.4.4. Main actors ¹

Governmental actors	<ul style="list-style-type: none">• The Ministry of Municipal Affairs (MOMA)• Municipalities (100 local municipalities)• Joint Services Councils -JSCs- (21 JSCs operating at Regional level)• The Ministry of Environment (MOENV)• The Greater Amman Municipality (GAM)• The Aqaba Special Economic Zone Authority (ASEZA)
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Private sectors	<ul style="list-style-type: none"> • Companies ("The first for paper & cartoon recycling", Entity green", "Jordan for recycling computers and electronic", etc.) • Haya Environmental Solutions - a private waste management company that provides collection, transportation, and landfill management services. • Sanergy - a private company that provides organic waste management services, including composting and biogas production. • Al-Ahliyya Amman University (AAU) - a private university that offers programs in environmental science and engineering, including waste management.
Associations & NGOs	<ul style="list-style-type: none"> • Jordan Environment Society • Bas waraq • Queen Zain Al-Sharaf • Friends of the Earth Middle East (FoEME) - a regional NGO that works on environmental protection and sustainable development, including waste management issues. • Arab Youth Climate Movement (AYCM) - a Jordanian NGO that works on climate change and environmental issues, including waste management. • Al-Hussein Society - a Jordanian NGO that works on disability issues and operates a waste management project that employs people with disabilities. • Edama - Sustainable Solutions for Energy and Environment
Academia	<ul style="list-style-type: none"> • The university of Jordan • Water, energy and environment center • Jordan University of Science and technology • Hashemite University • Al-Balqa' Applied University • Mutah university • Yarmouk University • Al-Hussein Bin Talal University • German Jordanian University • RSCN , • Higher Council Science & Tech , • Nat'l Energy Research Center, • RSS -Cleaner Production Unit,

1.4.2. Infrastructure

18 official disposal sites are currently operating in Jordan:

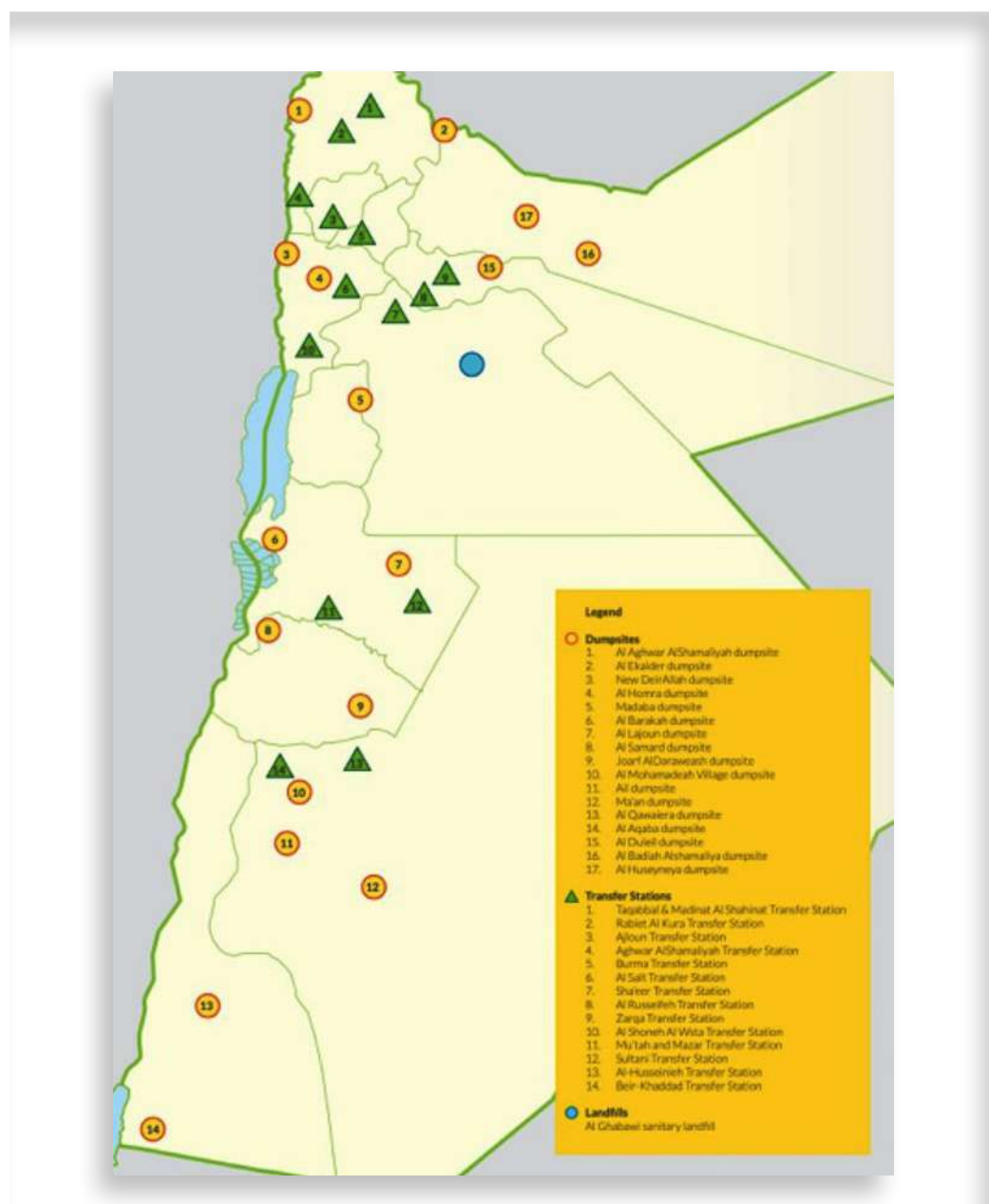
- 1 large final disposal site (FDS) operated by GAM: the only engineered sanitary landfill
- 17 FDS operated by JCSs

100 local municipalities and 21 JSCs in Jordan.

However, 18 official disposal sites are currently operating in Jordan:

- 4 of the said landfills operate in the Northern Region.
- 5 in the Central Region.
- 9 in the Southern Region of Jordan.

Figure 8: Dumpsites, transfer stations and landfills in Jordan (National SW strategy documents, draft report 2014, Country report on the solid waste management in Jordan, 2014, GIZ SweepNet”



1.5. Italy



1.5.1. Country profile

Population	59. 55 Million (2022)
Surface area	301.230 km ²
Municipal Solid Waste Generation	32 million tons
Per Capita MSW Generation	?? Kg/day
Collection rate of MSW	Urban areas: Rural areas:

1.5.2. Socio-economic and political situation

Italy's economy was heavily impacted by the global financial crisis and only emerged from recession in 2015; however, the country was one of the most affected by the COVID-19-induced crisis. After losing almost 9% in 2020, Italy's GDP rebounded by an estimated 5.8% in 2021, on the back of private consumption and higher investments. The Italian economy is expected to embark on a stable and sustained expansion path this year (+4.2%), thanks to investments financed by EU's Recovery and Resilience Facility (RRF), the easing of supply shortages, and an expansive budgetary policy. For 2023, the IMF forecasts a growth of 1.6% (2.3% according to the European Commission), a rate still sizeably higher than Italy's long-term average.

1.5.3. Waste Management situation

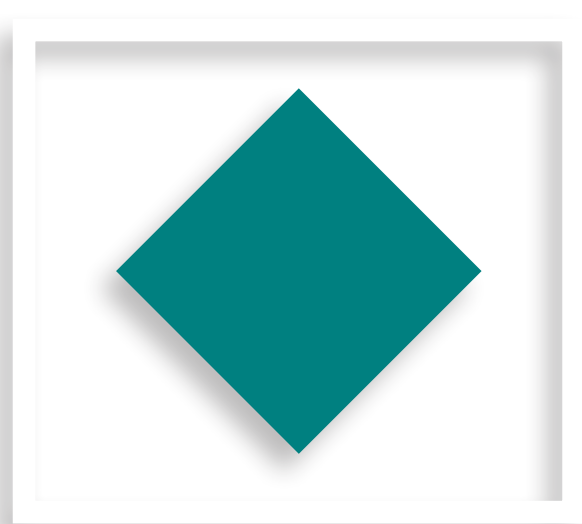
In Italy, the management of the waste cycle is emblematic of the many contradictions suffered by the country: the service does not improve while costs borne by families increase. In fact, from South to North, increases are recorded anywhere (more than 20% in Calabria, Molise, Umbria and Liguria) demonstrat-

ing the lack of a national policy for waste management, capable of binding the cost elements to elements of quality of the service, to the benefits of those who continue to operate in absolute lack of transparency. Consequence of all this is that in Italy more than 50% of the waste is still ending up in landfills, separate collection struggling in the Centre and South, and the involvement of citizens in the evaluation of the service provided since 2008, is still utopia.

The European Directive about Waste (200/98/EC), adopted by Italy in April 2010 (Legislative Decree December 3, 2012, No.205) surpasses the concept of recycling to give space to the recovery of the material. Therefore, focus should not be only based on how the collection of waste itself and the percentage of waste separately collected, but rather the actual recycling of the material collected. In practice, it is as if they gave for granted the objectives of collection established by previous legislation have now been achieved, and then they can look beyond, focusing on the recovery of what is collected in terms of matter and en-

ergy. Unfortunately, it is not so. In Italy only 34% of municipal waste is recovered, compared to the European average of 40%. This is the result of weaknesses (e.g. lack of a national waste strategy, problems of governance integration, monitoring and control activities to be improved) despite of Strenght (e.g. extensive legislation, increased awareness, improved collection of waste).

Half of the waste ends up in landfills, 15 million tons per year, while in Europe 38% of the average waste is landfilled. Countries that appear to be more virtuous are Austria, Germany, Belgium and the Netherlands that recover from municipal waste, respectively, 69, 62 and 61% of the raw material, with an almost non-existent landfill.



1.5.4. Main actors

Governmental actors	<ul style="list-style-type: none"> • Ministry of the Environment (MATTM) • Municipalities • Italian regional agencies for the protection of the environment (ARPAs) • SNPA • ISPRA (Italian Institute for Environmental Protection and Research) • ARERA - Regulatory Authority
Private sectors	<ul style="list-style-type: none"> • CONAI (National Packaging Consortium) private non -profit consortium for recovery and recycling processes • CORPELA (CONAI branch for the collection , recycling and recovery of plastic packaging) • CONIP (National consortium for hard plastic packaging collection) private • Acea Ambiente - a private waste management company that provides collection, transportation, and landfill management services. • Hera Group - a private waste management company that provides collection, transportation, and recycling services. • Eco Eridania - a private company that provides organic waste management services, including composting and biogas production.
Associations & NGOs	<ul style="list-style-type: none"> • WWF Italy • GREENPEACE Italy • Marevivo • Legambiente - an Italian environmental NGO that works on environmental protection and sustainable development, including waste management issues. • Zero Waste Italy - an Italian NGO that works on promoting the zero waste concept and reducing waste generation. • Slow Food - an Italian NGO that works on promoting sustainable food systems, including reducing food waste. • COSPE - An Italian NGO that works on social and environmental justice issues in various countries
Academia	<ul style="list-style-type: none"> • Italian Institute for Environmental Protection Research (ISPRA) • CNR - National Research Council (researches on plastic pollution /marine) • ENEA (Italian National Agency for New Technologies, Energy and Sustainable Economic Development) • CONISMA (National Interuniversity Consortium for Marine Sciences) • University of Bologna • University of Milan • Polytechnic University of Turin

1.5.4. Infrastructure

- 17 FDS operated by JCSs
383 landfills and incinerators
for hazardous and urban waste

- 17 FDS operated by JCSs
1700 recycling plans (including storage platforms and waste selection and treatment plants)

- 50 % waste goes to landfill

- 18% goes to national WtE plants

- 37 incineration (WtE) plants in operation

Figure 9: Trash cans on Italian beaches



1.6. Greece



1.6.1. Country profile

Population	11. 309 Million (2022)
Surface area	131. 957 km ²
Municipal Solid Waste Generation	5.007 million tons
Per Capita MSW Generation	1.18 Kg/day , 489 kg/cap-ita/year
Collection rate of MSW	Urban areas: Rural areas:

1.6.2. Socio-economic and political situation

The Greek economy was estimated to be among the most severely hit by Covid-19 despite the relatively limited number of cases and death rates in the country compared with most of Europe. This was mostly due to Greece's heavy reliance on tourism and the hospitality industry, which not only weighed on the trade and current account balance but also employment and domestic consumption.

However, the country's economy rebounded strongly in the second half of 2021, when real GDP reached its pre-pandemic level. Overall, Greek GDP is estimated to have grown 6.5% in 2021 (IMF), driven by a buoyant domestic demand and a better-than-expected tourist season. The launch of the European Recovery and Resilience Plan and a positive contribution of the external sector should drive a growth of 4.6% this year, followed by 2.6% in 2023 (IMF forecasts).

The pro-business actual government continued to make efforts to improve bureaucracy, while also proceeding to liberalize some

of the state-owned institutions in 2021. His centre-right New Democracy Party's absolute majority in the parliament allows for the swift adoption of policies. The government aims at improving tax collection and expanding the tax base to allow for tax cuts such as a corporate tax rate reduction in 2022.

1.6.3. *Waste Management situation*

Waste management has been recognized as one of the most severe problems in Greece's environmental performance indices, suffering from a low level of organization while relying predominantly on semi-controlled landfills until the end of the last century. Nevertheless, over the last two decades, solid waste management in Greece has undergone a remarkable improvement.

At national level, in 2018 a total of 5,523,809 tonnes of municipal solid waste were generated, compared to 5,277,209 tonnes in 2015 (a 4.7% increase in

the amount generated compared to 2015). The per capita generation of MSW amounted to 514 kg/capita/year in 2018, while the corresponding EU average was 489 kg/capita/year.

Disposal in sanitary landfills is still the main method of managing MSW (78.4% of generation in 2018); however, there has been a decreasing trend from 2015 onwards, mainly due to the gradual increase in recycling. In 2018, total recycling operations (including composting) constituted 20.1% of the management of MSW and was far behind the corresponding European average (approx. 47%). The percentage of energy recovery (oils, RDF, etc.) still accounts for a very small share of management (1.5% in 2018).



Figure 10: Trash cans in Greece

1.6.4. Main actors

Governmental actors	<ul style="list-style-type: none"> • Ministry of the Interior and Administrative Reconstruction • Ministry of Environment, Energy and Climate Change (MEECC/ YPEKA) • Ministry of Agriculture • Ministry of Infrastructure • Administrative Regions (13) and municipalities • Waste Transfer Stations (WTSs) • Hellenic Recycling Agency (HRA) - a public entity that manages and coordinates recycling activities in Greece.
Private sectors	<ul style="list-style-type: none"> • Producers Responsibility Organisations 5PRO) • Helector S.A. - a private waste management company that provides collection, transportation, and landfill management services. • ECOFLEX - a private company that provides organic waste management services, including composting and biogas production. • Geocycle - a private company that provides waste-to-energy solutions, including co-processing of waste in cement kilns.
Associations & NGOs	<ul style="list-style-type: none"> • Solid Waste Management Association (FoDSA) • Ecorec • GreekEcoProject • Ecological Recycling Society (ERS) • Boroume • WWF Greece - a Greek branch of the international environmental NGO that works on environmental protection and sustainable development, including waste management issues. • Hellenic Marine Environment Protection Association (HELMEPA) - a Greek NGO that works on marine environmental protection, including marine litter management. • Greenpeace Greece - a Greek branch of the international environmental NGO that works on environmental protection and sustainable development, including waste management issues. • MIO-ECSDE: The Mediterranean Information Office for Environment, Culture, and Sustainable Development is a regional organization that works to promote sustainable development in the Mediterranean region
Academia	<ul style="list-style-type: none"> • National Technical University of Athens (Unit of Environmental Science and Technology) • University of the Aegean - Department of Environment - Waste Management Laboratory • Aristotle University of Thessaloniki - a Greek university that offers programs in environmental science and engineering, including waste management. • University of Athens - a Greek university that offers programs in environmental science and engineering, including waste management.

1.6.5. Infrastructure

- Waste management relying predominantly on semi-controlled landfills until the end of the previous century

(European Environment Agency: Municipal waste management in Greece. 2013; available at: <http://www.eea.europa.eu/publications/managing-municipal-solid-waste> (accessed June 2016))

- Waste Transfer Stations (WTSSs),
- Sanitary landfills,
- Illegal Uncontrolled Waste Disposal Sites (UWDSs)
- 81% landfill, 19% recycling and composting (Greece : bottom of the European's sustainable waste management gradation) (Eurostat)
- Illegal dumping sites have shut down, round 50 are in restoration process

Figure 11: New garbage collection trucks



2. Governmental Initiatives to promote Waste Management and Circular Economy



2.1.1. Regulatory Framework

Waste management legislation in Tunisia refers to the set of laws, regulations, and policies that govern the collection, transportation, treatment, and disposal of waste in the country. The objective of these regulations is to promote sustainable waste management practices that protect public health and the environment.

The waste management legislation in Tunisia includes the 1996 Law on the Protection of the Environment, which regulates the disposal of waste in landfills and sets standards for the treatment of hazardous waste. Additionally, the 2016 National Waste Management Strategy aims to reduce waste generation, increase recycling and recovery, and promote the use of environmentally friendly technologies.

In Tunisia, waste management is the responsibility of local authorities, and the government provides financial and technical support to promote best

practices. The country has established waste management facilities, including landfills, recycling centers, and composting plants.

However, despite these efforts, waste management remains a significant challenge in Tunisia. Illegal dumping and inadequate waste collection and disposal practices are common, particularly in rural areas.

Here the major law

- Law 1996-1941 of 10.06.1996: amended by Law 2001-14 of January 30, 2001, on waste control, management and disposal;
- Law 92 – 122 establishing a de-pollution fund (FODEP);
- Law 1975-33 of 14 May 1975: promulgating the organic Law of
- Law n°97-11 of 3 February 1997, promulgating the code of local taxation;
- Decree 726-1989 dated 10/6/1989 relating to rural

councils entrusting waste disposal in rural areas to elected councils.

- Decree N° 2317-2005 of 22/8/2005: Establishing a national waste management agency (ANGED);

2.1.2. WM initiatives and programs

- FTE (Fonds de Transition Énergétique)
- FODEP (Fonds de Dépollution)
- FODEC (Fonds de Développement de la Compétitivité)
- Switchmed program
- ERPP (Production Propre et économies des ressources)
- Outil de comptabilité des flux matière (MFCA)

2.2. Lebanon

2.2.1. Regulatory Framework

The regulatory framework for waste management in Lebanon includes a number of laws and decrees. Law No. 444, enacted in August 1988, regulates hazardous waste man-

agement. Decree No. 8471, issued in 2012, relates to environmental compliance for industries. Decree 8006, amended through Decree 13389, classifies different categories of healthcare waste. Decree 8735/1974 designates solid waste and wastewater management as a municipal responsibility. Decree 9093/2002 provides financial incentives for municipalities to establish waste management facilities, including sanitary landfills and solid waste processing plants. Law 216/1993 assigns the Ministry of Environment (MoE) the responsibility of assessing all sources of solid waste generation. Law 444/2002 sets landfill standards and promotes recycling. Finally, there is a draft Law on Integrated Solid Waste Management that was approved by the Council of Ministers in 2012 and sent to parliament for approval under Decree 8003, dated 23/04/2012. The draft law is still under discussion in parliament.

WM initiatives and programs

- Switchers
- DAWWEER
- GIMED
- Energy Innovation Hub
- Sprout by Injaz
- GMI: Green Mediterranean Initiative. Youth (School and university) education on the importance of recycling practices and waste management issues. 52 reversible waste vending machines placed in public and private schools in Beirut & Mount Lebanon

2.3. Spain

2.3.1. Regulatory Framework

The Spanish Circular Economy Strategy (España Circular 2030) was approved by the Council of Ministers on June 2nd 2020.

An Action Plan for 2021 to 2023, aligned with the European Green Deal (EGD) and other relevant European strategies in relation to resource efficiency, competitive and low carbon economy is now under preparation. The Spanish Strategy intends to work through a series of action lines such as production; consumption; waste management; secondary raw materials; water reuse and purification; awareness raising and participation; research, innovation and competitiveness and employment and training. At a regional level, 4 out of the 17 regions have Circular Economy strategies, Navarre has a CE Agenda; Castille La Mancha has specific legislation; at a local level, more than 200 municipalities have signed the “Seville Declaration”, a Manifesto showing their commitment to circular economy policies.

In Spain, tax policy is decided, partially, at a regional level. Each authority can implement some green incentives or establish specific taxes (Example: Landfill tax, Incineration tax, Tax on disposable plastic bags, Tax incentives are offered to companies and individuals for making donations of new or reused goods.)

2.3.2. WM initiatives and programs

Specific funding lines for R&D in CE area.

26 technology and innovation platforms supporting the transition to a CE in Spain

Private platforms with initiatives in Circular Economy area : Foretica; Sustainability Excellence Club, COTEC, Recircular, Economía Circular en Acción;

Accelerator/incubator initiatives, dedicated to environment, sustainability, circular economy:

- Public initiatives : Fundación Biodiversidad Empleoverde

Project; Valladolid Urban lab; Ihobe: Circular Thinking;

- Private initiatives : Circular Hub (Basque Region); TheCircularLab (La Rioja region)

2.4. Jordan

2.4.1. Regulatory Framework

In Jordan, there are several key frameworks impacting the circular economy. One of these is the National Energy Efficiency Action Plan (NEEAP). Additionally, the Ministry of Environment has developed the SCP National Strategy and Action Plan 2016-2025, which focuses on three priority areas: Agriculture/Food production, Transport, and Waste Management. The Green Growth National Action Plan 2021-2025 (GG-NAP), developed with the support of the Global Green Growth Institute (GGGI), is another important framework in this context. Finally, the National Strategy for MSWM (2015) aims to enhance the overall Municipal Solid Waste Management

system by providing short, mid, and long-term planning frameworks, infrastructure, investments, and institutional settings at the national level.

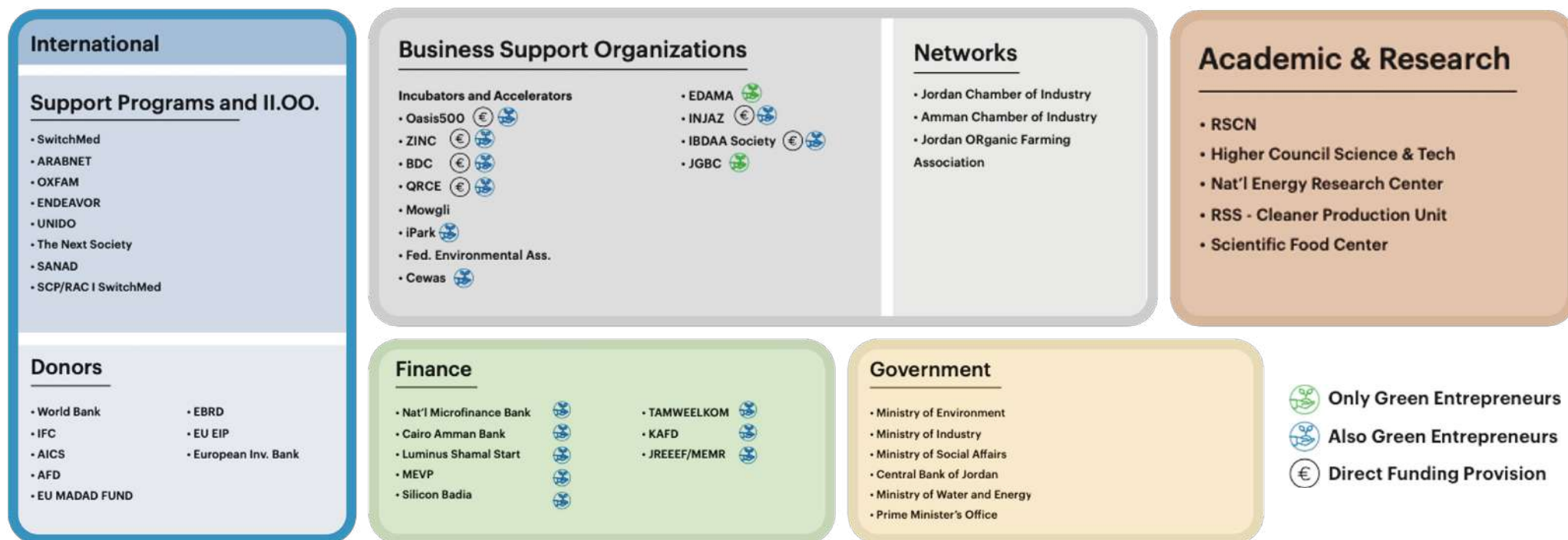
2.4.2. *WM initiatives and programs*

- Sanad,
- The Next Society,
- Arabnet ,
- Endeavor
- SWITCHMED



Green Entrepreneurship Ecosystem Map*_Jordan

*The map structure has been built upon Word Bank report “Igniting Climate Entrepreneurship in Morocco” - Word Bank Group, April 2017



Ref (Roadmap for scaling up Green Entrepreneurship) – Jordan, Switchmed

2.5. Italy

2.5.1. Regulatory Framework

The Italian national waste management system is regulated by Legislative Decree 22/97, which defines the responsibilities of the different actors involved. This decree introduced targets for separate collection of municipal waste, established the National Packaging Consortium, and provided for the gradual replacement of the old waste tax with a new waste tariff. Although Legislative Decree 152/2006 abolished Decree 22/97, it included most of its provisions. In addition, the Waste Framework Directive (Dir. 98/2008/EC) provides a regulatory framework for waste management across the European Union, including Italy.

2.5.2. WM initiatives and programs

- Eco-innovation action plan
- Ministry of the Environment, Land and Sea (MELS) :

NWPP – National Waste Prevention Programme

- PINPAS Programme
- “One planet food” WWF
- “Clean Plate Mission”

2.6. Greece

2.6.1. Regulatory Framework

Law 4042/2012 “on the protection of the environment through Criminal Law – Compliance with Directive 2008/99/EC – Framework for waste generation and management

- Compliance with Directive 2008/98/EC. Section II of that Law harmonizes the provisions of the WFD with national legislation [Hellenic parliament 2012].

measures and terms for solid waste management applicable for the national WMP are laid down in the Joint Ministerial Decision (JMD) 50910/2727/2003. The JMD has provided guidelines for the national and regional waste management planning for achieving compliance with the EU provisions on waste management.

Landfill Directive and Waste Acceptance Criteria (WAC)

Incineration Directive: JMD 22912/1117/2005 on “Measures and conditions for preventing and reducing environmental pollution by the incineration of waste” is transposing Incineration Directive into the national legislation.

Packaging Directive: Law 2939/01

Adoption of a Green Growth Strategic Action Programme (2010 - 2015);

2.6.2. *WM initiatives and programs*

The European Green Deal, is a set of initiatives proposed by European Commission to make Europe climate-neutral by 2050. Presently, only 38% of waste in the EU is recycled, the Green Deal aims to improve WM, stimulate innovation in recycling and limit landfilling.

The European Green Deal has a dedicated section to initiatives related to Waste and re-

cycling.

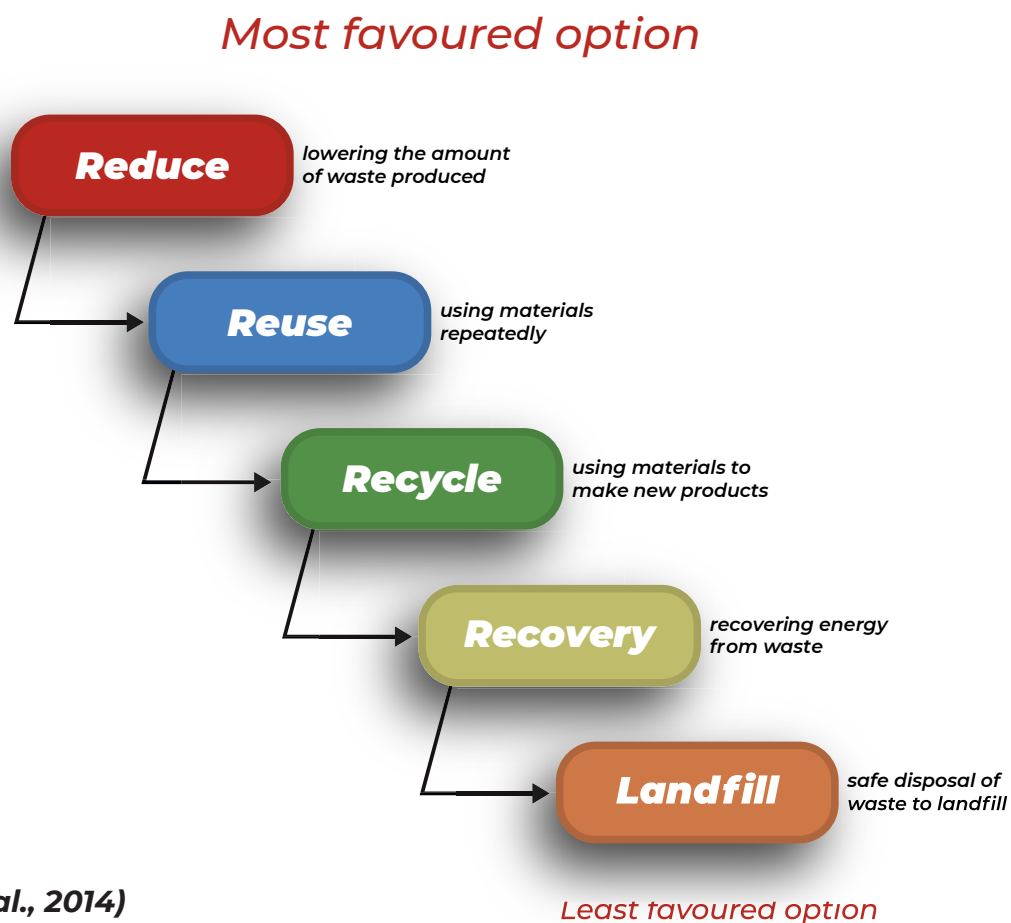
SMEs can benefit, in (i) short term from increased partnership opportunities and (ii) in the long term, better tools to improve their businesses.

(i) Buyers with sustainability commitments can work on ways to form supply chain partnerships with the aim of improving environmental and social practices (development of platforms like AtSource for example); SMEs could also benefit from international co-operation on research and innovation (for example list of Green Alliance and partnerships developed by the European Commission).

(ii) Support programs to transition, better tools and mechanisms to provide information on products and processing/production practices, policies and legislative measures.

One of the most interesting initiatives introduced within The Green Deal, is the five-step “waste hierarchy” established in the Waste Framework Direc-

tive, which introduces an order for WM. Preventing waste being the preferred option, and sending waste to landfill the last resort.



(Cole et al., 2014)

Figure 12: Five-step waste hierarchy, Cole et al, 2014

An example of extended solid waste hierarchy, is including human excreta and wastewater to guide actions to save and recover phosphorus (P) by three sectors : food industry, households and waste utilities. This novel system thinking and material flow analysis show that waste prevention can replace over 40% of mined Phosphorus used presently making fertilizers (Drangert, Tonderski and McConville, 2018) .



3. Opportunities

With recent estimates expecting waste generation to increase to 3.4 billion tones in 2050, (ref x) which represents a multiplication of a factor of three in low-income countries; inadequate waste management will increasingly pose a threat to environment, health and biodiversity. As a significant example, in the Mediterranean sea, according to last estimates of WWF, 600 000 tones of plastic produced and released is contaminating the food chains and ingested by people causing diseases that recent scientific studies are bringing to light (Li et al., 2022) (Expósito et al., 2022).

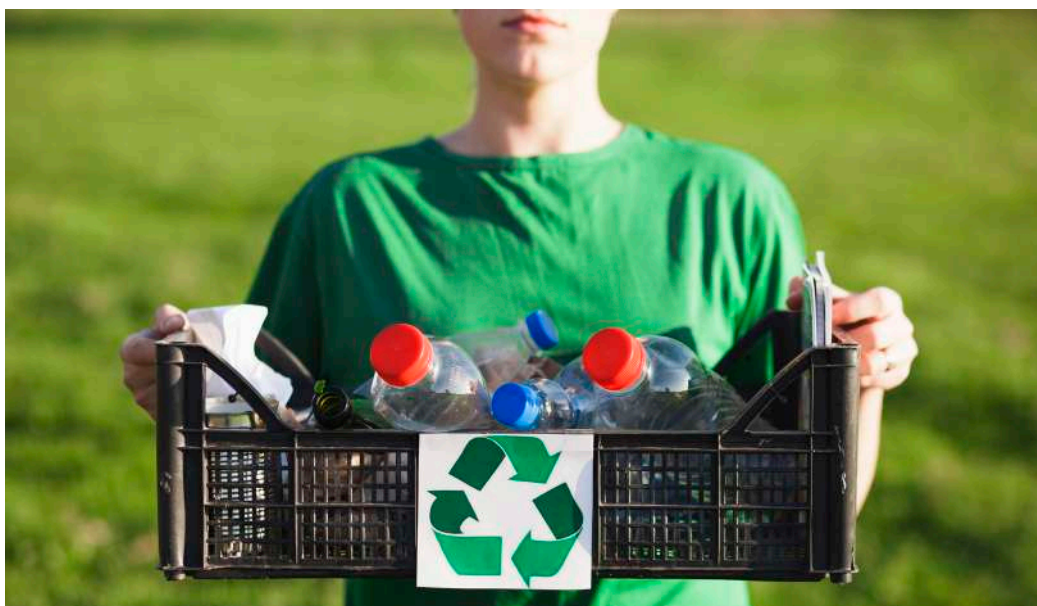
Therefore, Mediterranean countries need to work together to limit this waste pollution. The challenges are significant, but so are the opportunities. Indeed, Mediterranean business leaders and future entrepreneurs need to consider waste management problems as an opportunity to find innovative solutions.

Challenges:

Low collection coverage, irregular collection services, informal sector.

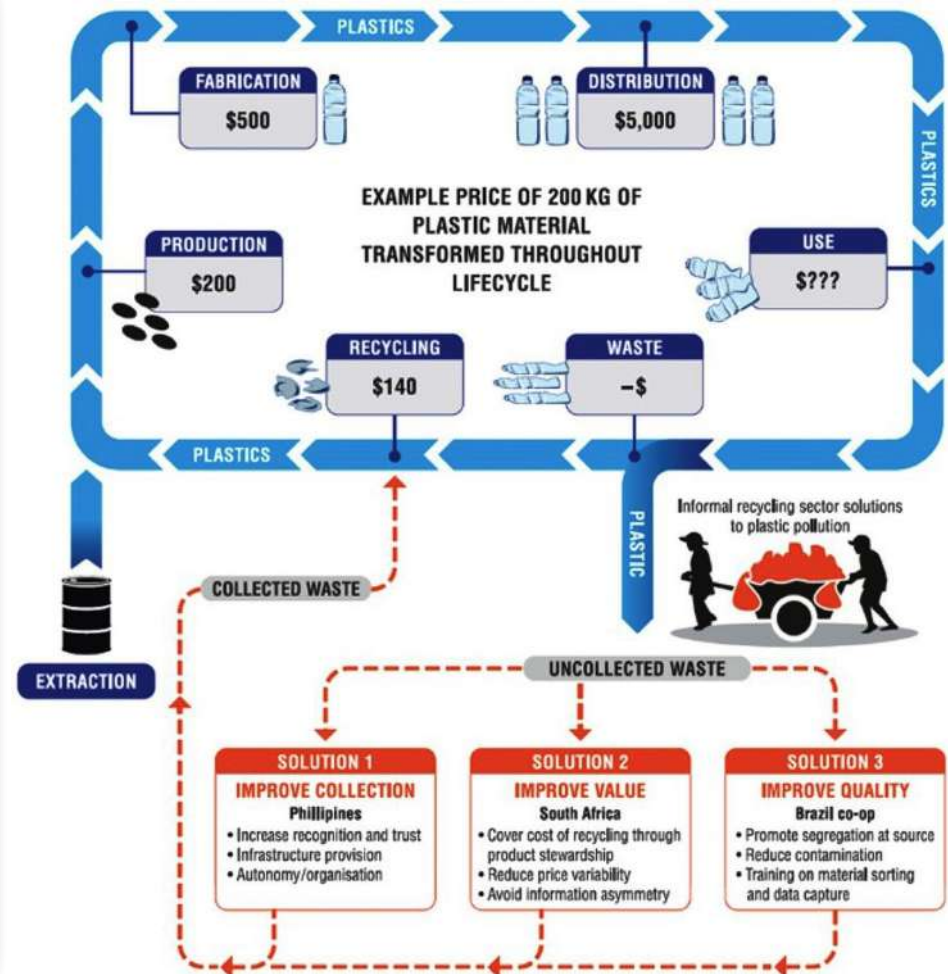
Opportunity for business companies:

Develop effective waste management systems, through smart waste management companies and new logistics models. Increase collection and treatment capacities, through new businesses and integrating informal waste pickers into processes (Velis et al., 2022), combined with useful applications for the recovered materials. Developing sustainable perspectives for treatment through Industrial Symbiosis (IS : strategy for waste utilization in a productive chain, based on physical exchanges of waste and materials, which finds ways to use the waste from one industry as inputs or raw materials for the other, all supported by business collaboration. (Boom Cárcamo and Peñabaena-Niebles, 2022).



*Including the informal sector to WM system provides rapid, inexpensive solution to plastic pollution, whilst supporting the livelihoods via their inclusion and empowerment. Scalable international solution to this global challenge : increase the collection rate, reduce pollution from plastics and help people escape poverty (*Velis et al., 2022*).

Figure 13: Plastic materials and products have different value at each stage of its life within a circular economy. Sufficient value should be available to be appropriated by those who collect, sort, and clean the materials, and the waste pickers need support in delivering this service at scale (Solution 1). The massive drop in value when plastic items become waste, and its direct competition with virgin material on price, does not help its collection for recycling at scale. This needs fixing, for example by product stewardship schemes such as (extended) producer responsibility (EPR) (Rutkowski, 2020), whilst prices should also reflect the environmental harm of particular items (Solution 2). By better understanding the necessary quality of recyclables, higher quantities of more suitable recycled materials can be targeted (Solution 3). All three solutions combined can serve as levers to prevent plastics pollution in a cost-effective, rapid, and socially responsible way. (*Velis et al., 2022*).



Challenges:

Lack of data on waste.

Opportunity for business companies:

Companies developing solutions and waste data bases, adequate assessment of the composition and volume of waste: deciding factor in choosing an efficient way to manage its disposal. Use of predictive models, that can connect observed waste concentrations with their sources: important for the designation of successful management plans and real-time monitoring of WM.

*Incorporation of the Internet of Things (IoT) with data access networks, geographic information systems and combinatorial optimization, using a waste-gathering approach based on supplying smart bins by using an IoT prototype embedded with sensors, which can read and convey bin volume data over the Internet. (Abdullah et al., 2022)

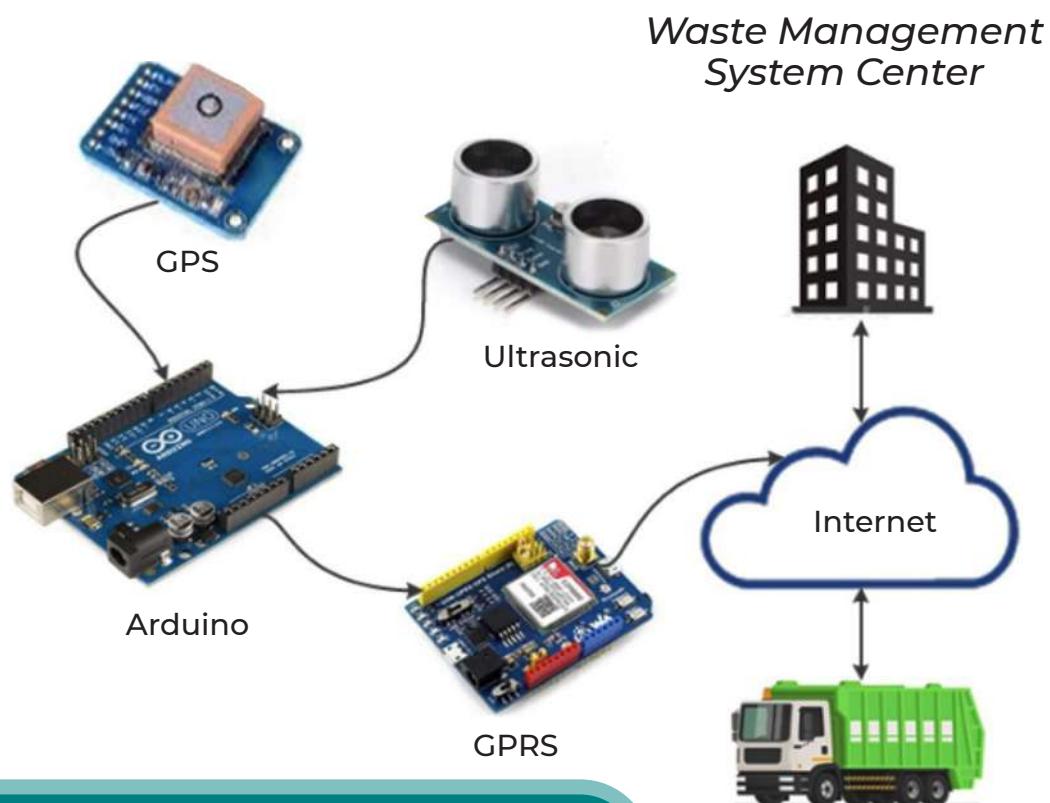


Figure 14: Integrated technology devices/ applications. (Abdullah et al., 2022)

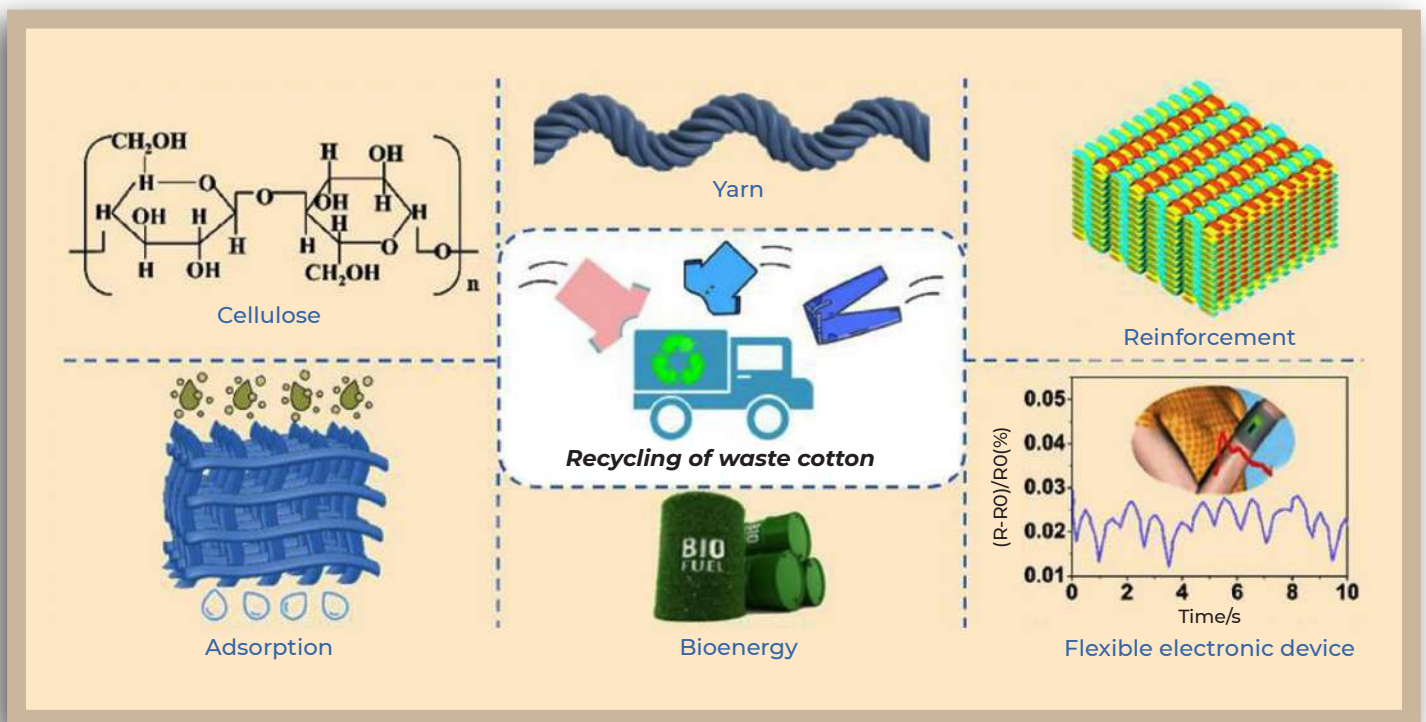
Challenges:

Waste mismanagement, pollution caused by inadequate practices (dumpsites, littering, unpolished open dumping and burning without air and water pollution control, etc.).

Opportunity for business companies:

Develop sustainable solutions: selective treatment, elimination and recovery. Develop more cir-

cular value chains for valorizing waste based on highly profitable recycling businesses : Plastic (into ploythene, plastic bottles, cans, buckets, adherent in construction etc.), waste paper (into paper cups, plates, packets, etc.), e-waste and hazardous material (raw materials cadmium, phosphorous, lead, etc. (Naik and Satya Eswari, 2022)), aluminum cans, water recycling food waste (biofuel, organic fertilizers, etc.), energy generation from landfill via methane extraction or thermal treatment, etc.



(Lu et al., 2023)

Figure 15: Characteristics of waste cotton and high-value products derived from waste cotton (e.g., yarns, composite reinforcements, regenerated cellulose fibers, cellulose nanocrystals, adsorptive materials, flexible electronic devices, and biofuels) via mechanical, chemical, and biological recycling methods.

Challenges:

Harmful and hazardous substances in material's composition.

Opportunity for business companies:

Highly profitable businesses focused on reducing / substituting harmful substances in material and products, by alternative bio-sourced materials, are a major opportunity in the Mediterranean region.

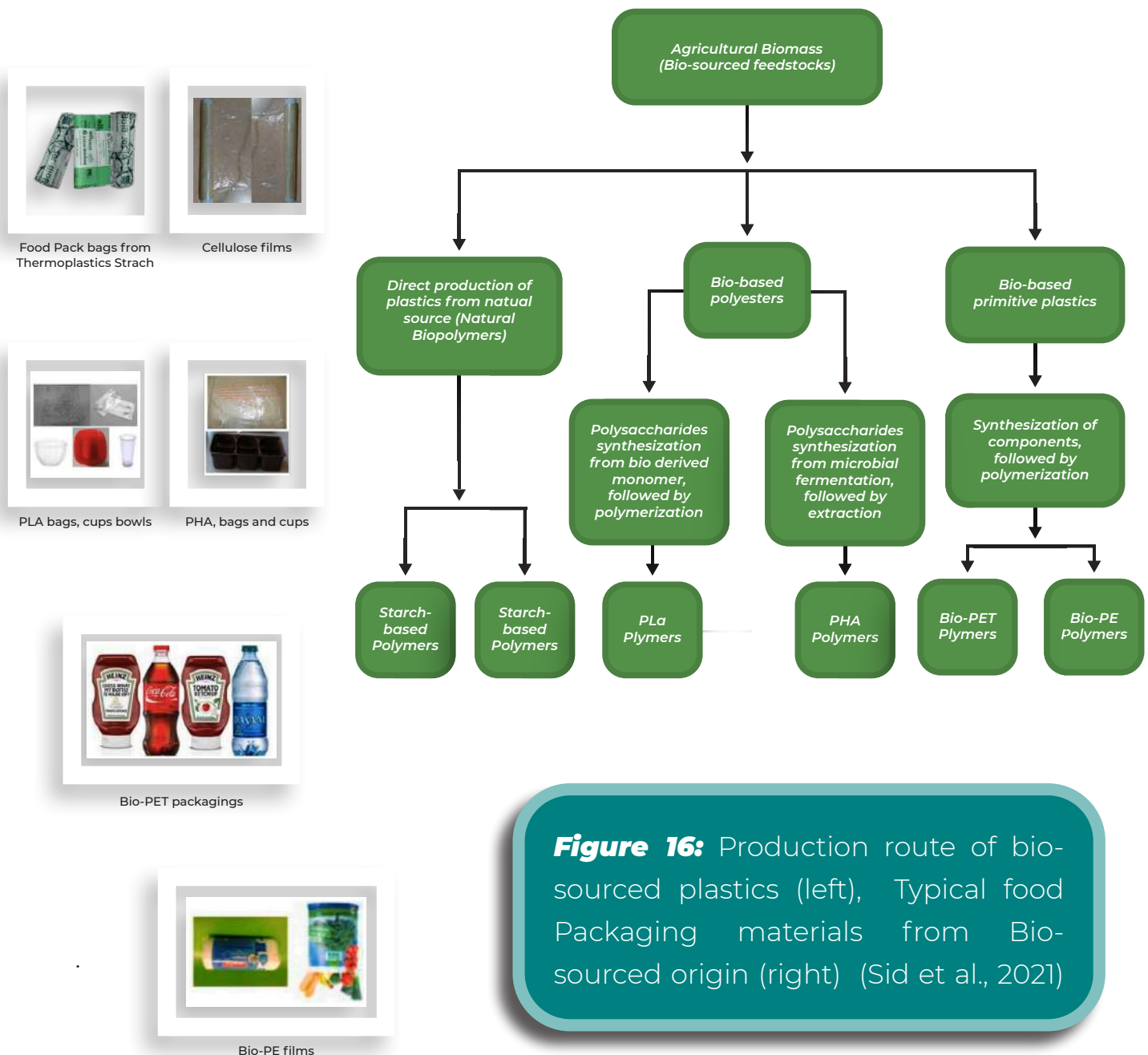


Figure 16: Production route of bio-sourced plastics (left), Typical food Packaging materials from Bio-sourced origin (right) (Sid et al., 2021)

Challenges:

Lack of human resources with technical expertise for waste management planning and operation, studies show that 80% of Mediterranean companies are requiring environmental expertise.

Opportunity for business companies:

Creation of specialized training offices, training courses dedicated to waste management in private universities, preparatory programs for certifications in related fields, etc.

Professional Training in Waste Dexterity



Advanced Diploma in Integrated Waste Management

Course Duration : 6 Months

Figure 17: Example of training program, 'Advanced Diploma in Integrated Waste Management'.

Challenges:

Low public awareness and education on waste impact and waste sorting.

Opportunity for business companies:

Move to waste segregation at source through waste sorting contains and tools companies. Develop dissemination tools of information on waste and consumer education (educational games and books for children).



Figure 18: Educational games on waste impact and waste sorting

WM Success stories



FOODEALZ:

Tunisian Tech Startup solving food waste management through a solution that let people buy discounted unsold and surplus food from coffeshops, restaurants and supermarkets which would otherwise end up in landfills. The startup was founded by Rim ELFAHEM (Telecommunications engi-

neering degree -Sup'Com Tunisia- Master's degree in software engineering-Ecole de Technologie Supérieure Canada-) and Iskander EL AMRI (Industrial engineer degree, Master's degree in mechanical engineering – Texas A&M University USA). Foodealz is the first and leading solution in the MENA region operating with more than 30 partners



Figure 19: Foodealz, Tunisian Tech startup in food waste management

EREMA:

Innovative recycling solutions designed to make plastics recycling as innovative and efficient as possible thanks to continuous research on new technologies and optimisations. Erema is a Spanish company, from pioneer to global market leader in plastics recycling machines and system components.



Figure 20: Erema, spanish company global market leader un plastics recycling

VUMA Biofuels:

Kenyan startup produces biofuel alternative for traditional firewood. This African startup uses discarded husks regarded as agricultural waste, to produce sustainable bagasse briquettes (double the heat output, longer burning duration, produce less smoke and pollution, lower ash content, etc.).



Figure 20: Vuma, Kenyan startup producing biofuel alternative

Recommendations

The last decades witnessed continued high levels of material consumption and waste generation in Mediterranean countries. This has drawn increasing attention to issues relating to waste management policies promoting the circular economy and new alternative solutions. The following are proposals that both corporations and governments may address to insure optimal waste management in Mediterranean countries.

Aspect A:

Business leaders and entrepreneurs

- ◆ Include green technologies in industrial processes.
- ◆ Enforce environmental standards as part of the certification process.
- ◆ Increase recycling, reuse and source reduction investments.

- ◆ Invest in recycling technologies and use of specialized waste processing facilities to separate recyclable materials. Develop new investments in electronic waste and waste-to-energy.

Aspect B:

Policy and regulatory

- ◆ Place WM as a priority issue at all levels of governance, harmonized regional, national and local WM policy framework.
- ◆ Enact favorable and appropriate policies and incentives to promote waste reuse, recycling and recovery.
- ◆ Create favorable environment to boost the private sector to invest in WM sector (Example: Incite private sector participation: Tax benefits for green and circular business / VAT reduction or exemption for second hand goods and repair services).

- ◆ Encourage through incentive mechanisms jobs creation in waste / resource conservation management. Develop regional markets for recyclables, waste material processing and waste disposal.
- ◆ Improve WM policies and regulations (taking account of constraints and differences in local conditions).
- ◆ Update policies according to technological progress (e-waste, etc.)
- ◆ Improve the practical implementation of laws.
- ◆ Implement the system of “user-pays’ to help people realize the implications of the volume and toxicity of waste generated.
- ◆ Design, construct and operate landfills with better technology with the goal to reduce future costs of pollution.
- ◆ Develop new conception of training system: Support awareness-raising campaigns on sustainable/circular practices among consumers.
- ◆ Develop guidance and training for public administrations
- ◆ Strengthen the capacity of local public authorities / public actors / private sector / NGOs
- Launch WM challenges (R&D and innovation)
- ◆ disseminate R&D results. Special focus on waste prevention, circular economy practices.



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