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January 2024

Online at <https://mpra.ub.uni-muenchen.de/119774/>
MPRA Paper No. 119774, posted 13 Jan 2024 11:10 UTC

Reviewing the Integrated Institutional Framework for Circular Economy in the European Union

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Abstract

The current waste crisis calls for a stable and integrated institutional framework. Policymakers try to untangle the complicated and interconnected acts, regulations, and directives in the European Union (EU). However, it is not a plain sailing to observe and implement the vast regulatory armamentarium of the EU in the circular economy (CE) sectors to achieve sustainable waste management (SWM). Aim of the present study is to showcase the historic – international and European – institutional framework on waste management as well as the main hazardous and special waste streams in order to build an integrated SWM framework. Moreover, CE necessitates for the safeguarding of critical raw materials (CRMs) and energy, in order to blueprint policies for the Net-Zero Age. Hence, the present study would show how CE can establish SWM, even though CE is going to face complex challenges till the conclusion of Agendas 2030 and 2050.

Keywords : EU; sustainable waste management; sustainable development; Agenda 2030; Agenda 2050

JEL Classification : Q01; Q5; Q53; Q58

Abbreviations:

| | | |
|--|---|-------------------------------------|
| BMPs: Best Management Practices | CDW: mining, construction, and demolition waste | CE: Circular Economy |
| CEAP: Circular Economy Action Plan | CLP: Classification, Packaging and Labelling | CRMs: Critical Raw Materials |
| DSD: Dangerous substance directive | EGD: European Green Deal | ELVs: end-of-life vehicles |
| EPR: Extended Producer Responsibility | EU: European Union | IED: Industrial Emissions Directive |
| NIMBY: Not-in-my-backyard | OECD: Organization for Economic Cooperation and Development | PAYT: Pay as you throw |
| PCBs/PCTs: polychlorinated biphenyls and polychlorinated terphenyl | POPs: Persistent Organic Pollutants | PPP: Polluter Pays Principle |
| PS: Product Stewardship | RoHS: restriction on hazardous substances | SDGs: Sustainable Development Goals |
| UN: United Nations | WEEE: electrical and electronic equipment waste | WFD: Waste Framework Directive |

1. Introduction

The rising population, mainly in urban environments, leads to more waste creation; however the institutional framework tries to catch up this novel crisis – the *waste crisis*. The present era can be described as a multi-crisis era due to the rising prices in energy or food, the pandemic, war and of course the waste conundrum. Circular economy (CE) is apparently a way to cope with the waste crisis, based on the principles of sustainable development, aiming to achieve integration in the European Union (EU).

Waste creates vicious circles. The economic growth surpassed many ecosystems' limits as Meadows et al. [1] forecasted, however there is no clear answer to what extent this phenomenon happens, nevertheless, population growth put strains on nature through over-exploitation of resources and waste generation in greater cities.

Therefore, a pivotal transition, that ought to happen in order to stop this vicious circle, is to avoid the mass production and consumption pattern and adopt the principles of CE. To exemplify, Stahel [2] necessitated for a “change economic logic” in order to diminish the created waste volumes through the “*R- strategies*” (e.g., reuse, recycling, and remanufacture).

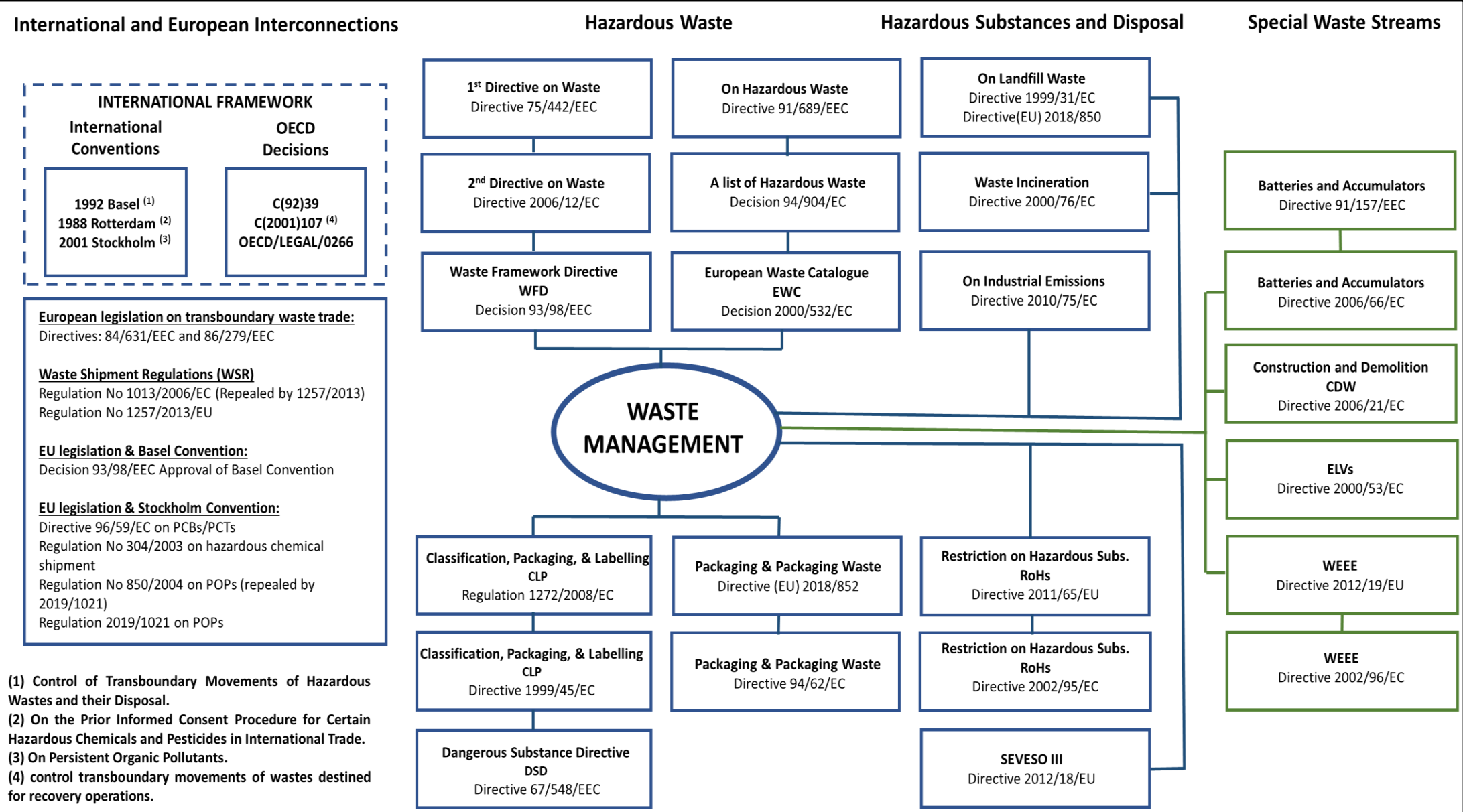
Sustainable waste management (SWM) is important in order to blueprint pathways to cope with waste crisis. As noted before, enormous waste volumes are created in or around the greater cities either from communal, commercial, and industrial activities, hence municipal solid waste management should be elaborately drafted. Pollution have detrimental effects on peoples' lives [3], for example, it has been observed that pollution can diminish employees' productivity performance [4]. In essence, it has been monitored by Halkos and Aslanidis [5,6] that municipal solid waste, if not treated properly, can lead to lower national productivity performance, making a problem to environmental integration in the EU.

Nevertheless, fiscal policy instruments can lead to lower CO₂ emissions [7]. Another important aspect to municipal solid waste management is that Halkos and Petrou [8] found the interlinkages between waste cultural factors, which can ultimately impact the whole society's attitudes, inter alia the Hofstede's [9] and Schwartz's [10] cultural dimensions.

Institutional framework follows specific circular strategies in the waste management sector. Environmental legal framework on SWM is based on notions like the “*polluter pays principle*” (PPP) [11,12] and “*pay-as-you-throw*” (PAYT) scheme [13–15]. These two ideas have different levels of application, more specifically, PPP refers to a country level, whereas PAYT schemes are applicable mainly at a citizen level. For example, in tandem with PAYT scheme, consumers ought to obtain a more responsible attitude through educational programmes (e.g., workshops or tutorials) about the negative externalities of waste.

Moreover, the schemes of “*extended producer responsibility*” (EPR) and “*product stewardship*” (PS) [16,17] try to put a strain on the waste generation from the secondary (i.e., industry) and the tertiary (i.e. services) sectors. Regarding CE, the priorities over the performance on waste generation is primarily based on the activities in the industrial and services sectors, followed by the actions at a country's or citizens' level [18]. In essence, all of these schemes enable policymakers to blueprint morally acceptable policies in order to cope with the waste crisis.

Fig. 1 International conventions and European directives regarding the waste management framework. Figure created by the authors.



The sustainable development goals (SDGs) from the United Nations (UN) that are focusing on waste generation and wellbeing in cities are SDG 11 (i.e. sustainable cities and communities) and SDG 12 (i.e. sustainable consumption and production) [19], but SDGs have also led to a mass production of institutional frameworks too. Thus, a brief categorization of these frameworks might usher, on the one hand, to a better understanding, and on the other hand, to a more effective adoption of the institutional framework by the Member States of EU.

The present research would showcase how institutional framework in EU (i) has changed, and (ii) novel proposal on achieving SWM. The research gap, that the authors would try to cover, is over the labyrinthine institutional framework in EU in terms of overlapping directives over waste, emissions, and raw materials. The goal of the study is to untangle this rambling framework into its important components in order to promote its effectiveness.

The novelty of this research lies with the concentration of the main – older and modern – directives over CE. The structure of the research is as follows: Section 2 presents the main historic – international and European – institutional framework pathway in line with other frameworks that are related to raw material, energy, and climate change. Section 3 discusses how this institutional framework can ameliorate sustainable development pathway in Europe, in addition, Section 4 demonstrates the main conclusions and policy implications over CE impact on institutional framework.

2. International and European Institutional Framework

The European institutional framework tries to encourage the raising of awareness of Member States via the promotion of best management practices (BMPs), as well as with state-of-the-art technological processes in order to ameliorate the rate of acceptance of these BMPs. Furthermore, the proper framing of SWM is being thoroughly acknowledged by the EU institutions and the civil European society as well. Hence, it is imperative that the institutional framework be explained on the succeeding chapters.

The following Figure 1 shows a brief depiction of Directives and Regulations on SWM. Moreover, the international conventions of (i) Basel, (ii) Rotterdam, and (iii) Stockholm are being described in tandem with the OECD Decision on transboundary waste trade. It should be mentioned that EU discourages transboundary waste trade as it is stated on the novel circular economy action plan (CEAP) [20].

2.1. Conventions on transboundary waste trade

International conventions provide the general idea of how to deal with great challenges (e.g. the waste crisis). The transboundary shipment of waste has been institutionalized by several international partnerships and conventions, for instance the Basel Convention, the Rotterdam Convention, and the Stockholm Convention.

In 1992 Basel Convention was signed and targeted the protection of people and nature by the unfavorable effects of transboundary shipments of – hazardous or non – waste, this convention has been approved by the European Council Decision (93/98/EEC, Article 1) [21,22]. The Basel Convention in Article 9 pointed on the illegal traffic (from the export country to the import country, without the consent of the latter) of hazardous or other waste on the basis of international law, except on the case that the export country re-imports the illegal waste shipment (Article 8). In the Annex I

of Basel Convention there is a column with the waste streams which should undergo special treatment (e.g. Clinical, mineral, and industrial waste), while in Annex III there is a list of waste characteristics which are signed as ‘H’, also known as ‘hazardous’. Finally, the core of Annex IV focused on the means of disposing waste in an order of different disposal - signed as ‘D’ i.e., disposal – operations (e.g. deposit into land, deep injection into wells or salt domes, and releasing into seas or oceans) or alternative uses labelled as ‘R’ strategies, i.e., ‘recycling, recovery, reclamation, or reuse’. It should be mentioned that Basel Convention was revised in 2019.

The same year (in 1992) OECD Council Decision C(92)39 was implemented in order to ‘control transboundary movements of wastes destined for recovery operations’. Additionally, the further harmonization of Basel Convention and OECD Council Decision was achieved in 2002 with the revision of C(92)39 by the C(2001)107, and in 2021 with OECD/LEGAL/0266 [23,24].

In 1998 Rotterdam Convention (and its revision in 2005) aimed the restriction (and banishment some) of hazardous chemicals and pesticides, and the banishment of these elements [25]. Furthermore, this Convention (in Article 1) proposed the strengthening of ‘share responsibility’ between stakeholders. A third important partnership between countries is the Stockholm Convention which has taken place in 2001. The Stockholm Convention addressed to the elimination persistent organic pollutants (POPs). EU has signed several legislative measures in accordance with Stockholm Convention, to exemplify, the Directive 96/59/EC on PCBs/PCTs, the Regulation No 304/2003 on shipment of hazardous chemicals, and Regulation No 850/2004 on POPs which has been by repealed by Regulation 2019/1021 [26,27].

The third international convention was held in Stockholm in 2001 and EU established core goals as: (i) the preservation of environmental quality, (ii) protection of citizens’ wellbeing, and (iii) not abuse of natural capital. The Stockholm Convention called for reduction or elimination of – intentional or unintentional – release of POPs, as well as the diminution of POPs levels in the long run. The EU has installed the Regulation 2019/1021 on this matter [27].

There is common understanding between international institutions and the proposed strategies for coping with transboundary trade of waste, which strategies and legislative measures EU has further implemented in its political agenda of the new millennium. In 1984 and 1986 the European Council Directives 84/631/EEC and 86/279/EEC set the foundations for proper supervision and control of trans-frontier shipment of hazardous waste. Next in order, the more contemporary legislative measures about shipping waste in EU are: Regulation No 1013/2006 (i.e., waste shipment regulation, WSR), and Regulation No 1257/2013 [28–31]. Furthermore, the proposal for Regulation on shipments of waste in 2021 as the WSR revision have be conglomerated with European Green Deal (EGD) and new CEAP [20]. An analogous Directive is 94/62/EEC, which focuses on the goals regarding waste packaging and treatment (i.e., Articles: 4,5,6,7), moreover the alert on packages with heavy metals (i.e., Article 11), this Directive has been slightly amended by Directive 2018/852 [32,33].

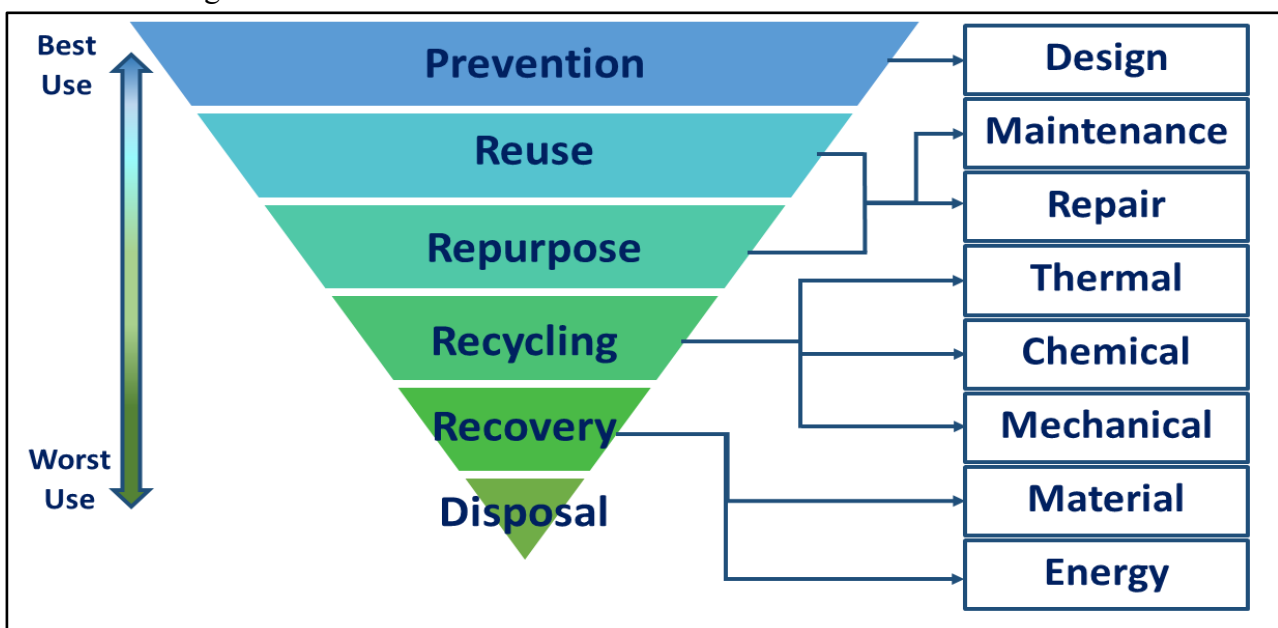
2.2. *Waste management of hazardous and special streams waste*

In 1967 the ‘dangerous substance directive’ (i.e. DSD) [34] and in 1999 a similar Directive [35] referred to the ‘classification, packaging and labelling’ of these elements produced either by natural or industrial procedures, the former directive imposed the necessary labelling of element as: name, origin, danger or risk symbol, and data of the distributor or importer (Article 6), while the latter introduced the ‘safety’ and ‘risk’ phases (Article 10: (2.5) and (2.6))[34,35]. These directives were

repealed by Regulation 1272/2008, (i.e., classification, packaging, and labelling, CLP), which provided a meticulous categorization of – dangerous or non – substances and mixtures (Article 1) [36]. However, there is clear answer to what extent would EU the bio-based plastics are going to be addressed in these regulatory schemes.

It was in 1975 that EU (then European Economic Community) adopted several environment-oriented actions on how to cope with waste at each stage from the source till the grave (i.e., from cradle to grave – C2G). In essence, it is imperative to discard the notion C2G and adopt the idea “*from cradle to cradle*” (i.e., C2C) as McDonough and Braungart [37] noted in order to achieve CE transition. In this Directive (75/442/EEC) in Article 1 waste was termed as “any substance or object which the holder disposes...”. While Articles 3 and 4 focused on the treatment of waste, the recovery of natural resources, and the terminology of negative externalities, was elaborated and strengthened by Article 11, in which the PPP was clearly stated [38].

Fig. 2 An alternative waste hierarchy and its components to waste management. Source: [39]. Authors’ editing.



The previous Directive was slightly amended in the terminology part by Directive 2006/12/EC, especially when referring to the necessity of initiating the development of clean technologies, the recovery through “recycling, reuse, or reclamation”, and the use energy derived from waste [40]. Furthermore, the aforementioned Directives were replaced from Directive 2008/98/EC or alternatively Waste Framework Directive (i.e., WFD), which imposed the majority of definitions over SWM and especially the “*end-of-waste*” status [41]. Eventually, in WFD the waste hierarchy was coined as a five-scale framework: (a) prevention, (b) reuse, (c) recycle, (d) other recovery (e.g. energy), and (e) disposal. Figure 2 illustrates a more explanatory depiction of waste hierarchy.

Waste hierarchy faces plenty of challenges as noted Halkos and Aslanidis [18] in a recent review. Waste hierarchy index estimates the MSW under the scope of CE, though in EU waste hierarchy index is applied improperly, in one study via scenarios there were higher rates on landfilling and lower standards on recycling, especially in Greece, Malta, Romania, and Slovakia [42]. Meaning that there is enough room for improvement, either in national, or in EU level. Additionally, Ewijk and Stegemann [43] distinguished the incapacity of waste hierarchy on addressing the matter of “*dematerialization*”, however they admitted the importance of waste hierarchy as a means of categorizing generated waste.

Criticism of waste hierarchy focused on three important omissions: neglect of prevention strategies because it does not belong to waste managers' jurisdiction, insubstantial incentivization, and absence of guidance over hierarchy's ranks [43]. Additionally, some identified barriers to waste hierarchy could be: neglect of – quantitative or qualitative – issues in education or public awareness, illegal dumpsites, lack of economic or financial incentives, distance to landfills, feeble institutional interference, rudimentary waste collection, and ultimately the “absence of holistic waste collection” [12].

In WFD the Articles 7 and 17-22 call for further classification of the composition of waste (e.g., hazardous), for instance Annex III of WFD contains the categories of hazardous waste (e.g., explosive, oxidizing, toxic, carcinogenic, infectious, etc.). While Articles 8, 15, and 16 provide explanations over the extended producer responsibility under the scope of PPP and the principles of self-sufficiency and proximity via the adoption of best available techniques, given the “economic viability, technical feasibility and protection of society and environment”. To conclude, SWM is undoubtedly the core of this Directive, however there is no negligence of public participation, as the involvement of citizens in SWM is an intrinsic part (Article 31).

The hazardous waste management was slightly referred in Directive 75/442/EEC, but in 1991 on Directive (91/689/EEC) it has been clearly ordered to Member States to not mix different types and classes of waste (e.g., in Annex III of this specific directive) [38,44]. Directive 91/689/EEC was tied with Decision (94/904/EC) which displayed an analytical list of hazardous waste, which was further strengthened by the Decision (2000/532/EC) (i.e., European Waste Catalogue, EWC) [45,46]. In EWC there was the distinction of waste into two types, the first is called as “*absolute entries*” which is the hazardous waste disregarding the concentrations or composition of the contained substances, and the second type is called “*mirror entries*” which contains a potentially-harmful substance, but it is called as hazardous when there are violations of limits according to the legislative system [47]. It should be indicated that this Directive and Decisions were consolidated in WFD, however they enclose various important details on hazardous waste management, hence it is advisable that they should not be neglected.

The previous directives and regulations presented the wide anxiousness and apprehension of legal institutions of EU over hazardous waste. Next in order, the special streams would be shown, which account for the bulk of waste in EU and they consist also a very important aspect of SWM. Special streams of waste are: electrical and electronic equipment waste (WEEE), batteries and accumulators, end-of-life vehicles (ELVs), mining, construction and demolition waste (CDW) [48].

For WEEE the directives 2002/95/EC on restriction on hazardous substances in EEE (i.e., RoHS) (repealed by 2011/65/EU) and 2002/96/EC (2002/96/EC repealed by 2012/19/EU) set the background into the EU legislation. Directive 2002/95/EC defines in Article 3 the equipment with “electric currents or electromagnetic fields” [49]. The RoHS Directive focused on prevention procedures (Article 4) and obligations of manufacturers under the scope of EPR (Article 7) [50]. Though the necessitation of separate collection, the disposal, treatment, and the collection rate are highlighted in Directive 2012/19/EU (Articles 5, 6, 7, and 8), whereas in Article 10 there is mention regarding the shipment of WEEE [51].

Another aspect of special streams of waste are ELVs which in Directive 2000/53/EC in Article 4 there is profound mention on EPR. Because it is clearly stated that “vehicle manufacturers and material and equipment manufacturers” ought to: (i) limit hazardous elements, (ii) expedite the “reuse, recovery, and recycling” of the dismantling parts, and (iii) utilize recycled components in vehicles [52].

Waste batteries and accumulator were stated in Directive 91/157/EEC, but now Directive 2006/66/EC repealed the previous one. Article 4 distinctly declares the restriction of mercury-burden batteries over 0.0005% per weight, except in cases of medical or emergency equipment [53]. In Article 8 there is a categorization of different collection schemes like: the users ought to discard batteries or accumulator on the proximity of their households, without fee, and with no obligation of buying novel batteries.

CDW is being legally bind to Directive 2006/21/EC [54]. The waste management plan necessitates in Article 4 the taking of measures as: prevention or reduction of negative externalities, either on the design, or on the end of production operations. According to the same Article 4, after the operations some countermeasures ought to be taken like: preservation of topsoil and surface area, injection of the produced waste into the “excavation void”, encouragement of recovery of the field of operations, and safeguarding – on the short and on the long run – the extractive waste disposal. Moreover, communication with stakeholders (like the public) should exist, in order to cope with not-in-my-backyard (i.e., NIMBY) movements, as stated in Article 6 the prevention of negative externalities, like major accidents to the citizens and the environment.

Lastly, two other directives that should be mentioned are: Directive 2010/75/EC on industrial emissions and Directive 2012/18/EU SEVESO III. The former directive on industrial emissions try to formulate either the prevention measures of harmful emissions, or the control of the industrial plant on the matter of used materials and emissions [55]. The latter directive “SEVESO III” could be combined with CLP of chemicals directive, due to harmony with these two legislative measures for environmental, economic, and societal protection [56]. According to historic aspects in 1976 a calamitous accident took place in Seveso, Italy which was to be the foundation of the SEVESO-directives, the first Directive was ratified in 1982, the second in 1996, and the third one in 2012 [57].

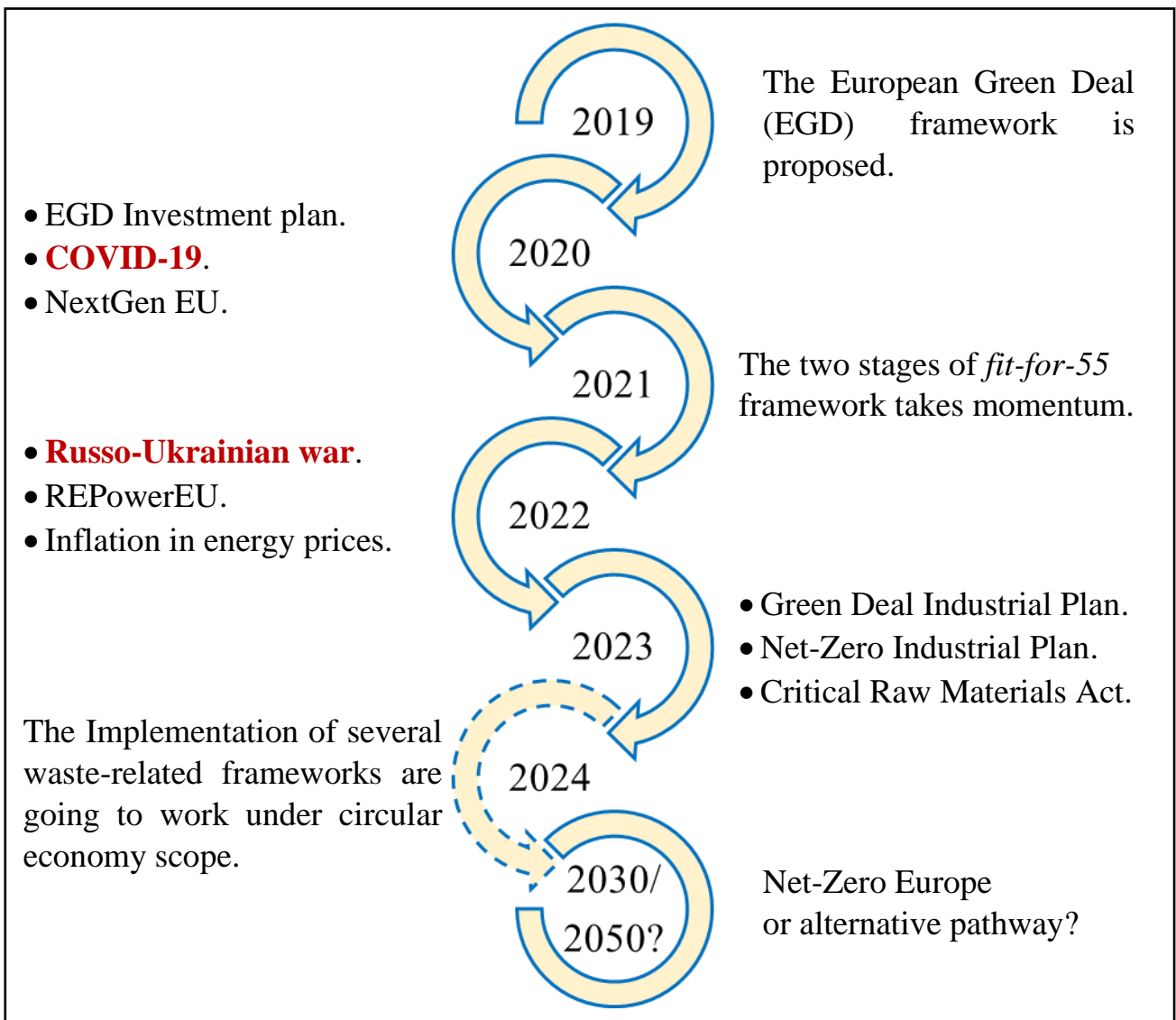
2.3. *The future of critical raw materials, energy, and emissions*

Crucial for technological advancements are raw materials and energy; hence CE sectors would try to safeguard their management in order to attain greater productivity. Unequivocally, the Russo-Ukrainian war trebled the geopolitical status-quo. The energy crisis emerged after this conflict, followed by inflationary food prices as well with detrimental impacts on everyday necessities [58].

The REPowerEU [59] necessitated for European *energy self-sufficiency*, mainly due to the Russo-Ukrainian conflict, but it also paved the way for other needs (e.g. the focus on raw materials). Moreover, the State of the Energy Union Report [60] aims primarily to decarbonization and energy security as well as to innovation and competitiveness. Thus, it is expected that CE sectors in SWM would try to derive as much energy from waste as possible in order to be in tandem with the aforementioned frameworks.

Furthermore, the twin transition in the EU is going to be addressed through the net-zero technologies and the *critical raw materials* (CRMs). EU has set priorities over the matter of CRMs, in more detail, the EU’s annual consumption for extraction, recycling, and processing by 2030 would be at least 10%, 15%, and 40% respectively [61]. Figure 3 depicts a summary of events that could lead to the adoption of CE initiatives and strategies till the conclusion of Agendas 2030 and 2050. European Commission proposed CRMs act in line with the EGD and the European Climate Law in order to strengthen strategic manufacturing technologies (e.g., semiconductors) in order to mitigate the emission levels in the EU.

Fig. 3 Important milestones for circular economy framework in Europe. Figure produced by the authors based on Figure 1 in EC [60].



Hence, the CRMs act is going to be in harmony to the Net-Zero Age plans such as (i) the Green Deal Industrial Plan [62], (ii) the fit-for-55 package [63], the Industrial Emissions Directive (i.e., IED) [64], and (iv) the new CEAP. Overall, the target for the European pathway towards a circular economy and circular industrial economy transition is based on energy recovery, sufficiency, and security.

3. Discussion

SWM is being strengthened by perceptions, principles, and policies. For instance, SWM in Europe is based on PPP, PAYT strategies, EPR, and PS schemes, while the institutional agenda of EU is based on international conventions of UN (i.e., Basel, Rotterdam, and Stockholm). The OECD decisions were also a matter of great significance, especially for transboundary trade of waste or hazardous chemicals like POPs.

Additionally, the WFD directive is the nucleus of the present institutional framework regarding waste in EU, accompanied by several other directives and decisions. Essentially, the special waste

streams (CDM, ELVs, WEEE, batteries and accumulators) consist of several important directives for their particular meticulous processing and proper discarding. All of these waste streams are of utmost importance in the EU waste institutional framework as they are interlinked with the integration of EU in circular sectors.

Undoubtedly, the European institutional framework is complex. SWM would focus on ways to retrieve energy from waste and to minimize negative externalities. Nevertheless, the complexity of regulatory procedures might confuse policymakers in the waste management sectors. For instance, several directives attributed at SWM do not cover the future of bio-based plastics (e.g., Directive (EU) 2018/852 - the Packaging and Packaging Waste Directive) or POPs. Thus, it is imperative that the waste hierarchy to be expanded to these matters as well, because it neglects the importance of ‘‘who is going to implement’’ the strategies either in the first levels (prevention, reuse, repurpose) or till the final step of their disposal. Waste hierarchy ought to be restructured in order to cover the aforementioned issues in terms of dematerialization actions and illegal dumping.

EU aims to become the first Net-Zero continent through circular economy solutions and innovation. Prerequisite for this target is to achieve energy security and access to secure sustainable supply of rare earth metals. The CRMs are pivotal for each stage of the pathway to Net-Zero status as they are the foundations of technological advancements and innovation. CRMs are also interlinked with plenty of European frameworks (e.g., EGD).

4. Conclusions and Policy implications

EU’s framework on CE and especially on SWM is complex, but in general, in a proper basis. EU adheres to international convention on waste and its management, but the conundrum lies with the harmonization of Member States’ regulation to the European and moreover to the international.

Policy implications that can strengthen the EU’s CE framework can be applied at three levels, i.e., civil society and non-profit organizations, private sector, and government. Firstly, citizens ought to be educated (via workshops, living labs, or tutorials) on how to consume responsibly, based on their real and not fictional needs. In this matter, people can deal with consumptive patterns, imposed by social media, through the PAYT schemes. Secondly, the industrial sectors should provide goods and services through EPR and PS based on the responsible business archetype. Lastly, the Member States in the EU should comply with the PPP, because this principle is pivotal in environmental regulation and specifically on SWM.

Regarding the future pathways, CE is in need of a robust and integrated institutional framework. EU has proliferated its efforts to become the first Net-Zero continent. However, this should not be done at risk of EU’s competitiveness and innovation. EU ought to focus mainly on the remanufacturing sector, aiming to accelerate its circular transition, but also respect the dynamic environment of the USA-China tug of war. Having this in mind, USA and China are collaborators and competitors at the same time, hence EU framework might better focus on how to become competitive in the CE sectors and in parallel try to cope with the waste crisis.

Declaration of Competing Interest: The authors declare no conflict of interest.

Author contribution: Equal author contribution.

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