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Different pathways to a recycling society – Comparison of the transitions in Austria, Sweden and Finland

Hanna Salmenperä

Finnish Environment Institute, Latokartanonkaari 11, 00790, Helsinki, Finland

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ABSTRACT

The European Union has set strict recycling targets for municipal solid wastes, but the implementation of circularity is still hindered by a variety of present set-ups. This paper addresses the recycling transitions and their complex nature in Austria, Sweden and Finland and points out the differences that are connected to the level of success in recycling. Furthermore, this study identifies present lock-ins in the waste management regime to provide an understanding on the factors preventing further development towards a recycling society. This is done by analysing different waste policy documents and interviews of national waste experts. The study employs the multilevel perspective (MLP) framework that is a commonly used approach in sustainability transitions research. The results highlight the variety of social, political, technical and economic elements, but also the connections between them that result in a stable regime. The pathways to achieve the recycling society differ between Austria, Sweden and Finland. National waste policy, the division of responsibilities, the variety of infrastructure and collection systems in waste management, the level of general awareness, public-private co-operation and the quality of waste data act as key characteristics that reflect the success in the recycling transition. Identified lock-ins for recycling seem to be slightly stronger in Finland compared to Austria and Sweden, while some of the lock-ins are the same in all countries, such as incineration capacity, malfunction of markets of recyclables or lack of product design for recyclability.

1. Introduction

Natural resources are increasingly extracted in unsustainable ways and used in a wasteful manner which has resulted in global concern for their adequacy (UNEP 2011). Socio-technical systems perform core functions for society, for example transport and energy supply, and also waste management (Geels, 2017; Duygan et al., 2018; Markard et al., 2012). Waste generated from production and consumption cause environmental problems, which creates a need for various functional changes on a systemic level. Waste can be seen as a potential resource (Ghisellini et al., 2016; Singh and Ordonez, 2016; Stahel, 2016) and managing waste as an elemental part of implementing circular economy (CE) (Duygan et al., 2018; Nowakowski and Mrówczyńska, 2018), a concept which has been introduced as a useful approach in solving the problems caused by 'take-make-dispose' material use (Ghisellini et al., 2016). The CE encompasses the idea of restorative and regenerative economic system, where products are designed and used in an efficient way while maintaining their value along all phases. In the dual system, technological materials cycle from repair and refurbishment of products, into the remanufacturing of components and finally into recycling whereas the biological materials are returned back to the biosphere as nutrients via composting and anaerobic digestion.

As recycling can be considered to be the most practiced way to promote CE, it has also been criticised for its limitations (Ghisellini et al., 2016; Haas et al., 2015). Some materials cannot be recycled multiple times, recycling has the potential for displacing the virgin materials only to certain extent, increasing recycling can mean increased environmental impacts and much of the present recycling can be considered as down-cycling where the value of the material is decreased due to the low quality recyclables (Geyer et al., 2015; Fellner et al., 2017). Haas et al. (2015) see that circularity is challenged by setting the focus on treating wastes, while forgetting the more urgent strategies like decisive eco-design. In addition, there is a need for a novel mindset on looping the products and materials and the roles of the operators (Salmenperä et al.,

E-mail address: hanna.salmenpera@syke.fi.

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2021; Nowakowski and Mrówczyńska, 2018; Ghisellini et al., 2016; Haas et al., 2015). Despite the limitations, many consider waste management to play an important role in CE. While the advantages of recycling depend greatly on the waste type, municipal waste poses a crucial role in promoting CE (Taleb and Al Farooque, 2021).

In studying the implementation of the CE, policies and practices at different levels of operations are in a key role (Ghisellini et al., 2016). Savini (2019) has studied circularity in practice at national, regional and municipal levels and finds that the implementation is not as ambitious as the first interpretations of CE. Thinking of the levels is also relevant in waste management (Hansen et al., 2002). (EEA, 2013) stresses that the regional and local policies have a significant impact in increasing recycling, while the EU and national targets are the key elements in managing municipal wastes. The significance of city, region and country levels in waste governance is also emphasised by the principles of EU waste policy, e.g., the proximity and self-sufficiency. Furthermore, the centralized and decentralised approaches at different levels of waste governance determine the sustainability and efficiency of the waste management system (Massaud et al., 2019). Waste policy and its successful implementation at different levels links strongly to actors and their interactions (Duygan et al., 2020; Le et al., 2018; Joseph, 2006). Malinauskaite et al. (2017) find that the lack of cooperation between local and national operators is hindering the implementation of CE principals into practical waste management. While a significant number of studies on CE implementation cover Chinese cases, Ghisellini et al. (2016) call attention to research about putting CE in practice in different levels of operators in EU area.

Earlier studies and waste statistics that the transition from traditional provide evidence waste management to a more circular system is still under way all over the world (Zhang et al., 2019), and in the EU as well (EEA 2018). This is also argued by de Witt et al. (2018), who state that the global economy has been estimated to be only 9% circular currently, and developing countries are still struggling with basic challenges in public health and environmental protection. However, the ongoing transition in developed waste management systems has also been addressed in a few studies (Lauridsen and Jørgensen, 2010; Jackson et al., 2014; Duygan et al., 2018; Fellner et al., 2017). The perceived transition is happening at a varying pace in different countries. Despite the efforts, the objectives of the waste recycling policy seem challenging for most countries (Silva et al., 2017; Ghisellini et al., 2016; Lauridsen and Jørgensen, 2010). Simultaneously, much of waste management research is focused on solving technological issues that neglects the systemic approach to enable material cycles.

The purpose of this paper is to study the transition towards a high-performing recycling society in three countries (Austria, Sweden, Finland) by applying the multi-level perspective (MLP) approach. MLP provides a three-level framework that describes the systemic change, and the study explores the systemic elements, dynamics and lock-ins. In this study, recycling society refers to a society where wastes replace the need for virgin materials in production and the recycling of wastes is carried out in sustainable ways that minimise the risks to the environment. A recycling society also meets the aims of a circular economy. This study focuses on the regime level, highlighting the importance of the constantly changing set-up between regulatory and technical systems and interacting markets, practices and beliefs. As Wilson (2007) states, there is always a diverse group of drivers for development in waste management, and it differs from country to country.

Instead of conventional waste treatment, the supply of raw materials into the needs of production makes the research topic multidimensional, as it is not necessarily a question of the waste regime itself, but that other regimes can engage in e.g. raw material markets, entrepreneurship and innovation policy or energy regime. Transition is understood as a complex, non-linear process resulting from interactions between changes happening at different levels (Geels, 2017). It is also a slow process that also includes stagnant periods and barriers hindering the change; understanding the transition is a prerequisite for governing it and avoiding possible hindrances and removing existing lock-ins. Geels (2017) states that commonly approved goals can be achieved through different paths, using different measures and activities.

The number of earlier studies using MLP in waste management transition is limited. However, they all show that the framework can help understand how the transition is happening and how it can be governed in both developed and developing countries. For example, Raven (2007) has studied the co-evolution of waste and electricity regimes by using multilevel perspective, showing that interactions between regimes can significantly influence the transition. Karakaya et al. (2018) and Jackson et al. (2014) studied the managing of metals and the metal industry in circular economy. They stated that MLP is a useful framework for looking at the macro patterns of change. Also, Forbord and Hansen (2020) studied processes and the role of actors in the transition to biogas production and public transport in Norway. Lozano Lazo and Gasparatos (2019) used MLP to study sustainability transitions in the municipal solid waste (MSW) Systems of Bolivian cities, whereas Biyani and Anantharaman (2017) studied transition management (TM) in solid waste in India to facilitate better governance and stakeholder engagement. My study contributes to this field by providing new insights into how the municipal solid waste recycling transition can be structured to point out the importance of various elements in different levels.

This study observes the transitions and their complex nature in three countries and operational environments to point out the differences which might be connected to recycling success and also provides knowledge of the things that need to be changed. Identification of lock-ins will provide important knowledge for policymakers and further enable governance of transition in choosing the suitable policy tools. The research questions are:

1. What are the characteristics that represent the MSW recycling transitions in Austria, Sweden and Finland during the past decade?
2. What are the current country-specific lock-ins that prevent further development towards a recycling society?
3. How do the transition paths in these countries differ from each other?

Empirically, this is done by a comparison of the development towards a recycling society in three well-performing EU countries whose MSW recycling performance differ slightly from each other. According to the EEA (2018), there are no specific reasons for the high recycling performance. It is more likely explained by a combination of policy tools in connection with the operational and cultural environment. Studying individual countries as cases increases the understanding of the variation of how waste management transitions can progress and the kind of interactions between key players and different levels that occur.

2. Analytical framework and methods

2.1. Multi-level perspective

Multi-level perspective (MLP) is a conceptual framework for understanding sustainability transitions (e.g. Geels, 2017). MLP pays attention to complex system transition, where multiple processes and interactions between different actor groups happen.

MLP presents niches that are locations where it is possible to deviate from the rules and replace or change the practices in the existing regime (Geels, 2004; Smith et al., 2010) and break the existing lock-ins. Regimes are dynamically rigid systems composed of shared rules, practices and institutions. Landscape developments are slowly changing external factors that provide pressure for changes in the regime (Geels, 2002). Changes in the landscape level and destabilisation in the socio-technical regime may create so-called windows of opportunities that allow the niche innovations to transform the regime (Geels and Schott, 2007; Geels, 2002). All these three levels are co-evolving during a transition.

This study uses MLP to explain the reasons for development at the regime level. Buclet and Godard (2001) introduce key variables that represent the differences between the national waste policies: the nature of the objectives and the presence of waste prevention; the techniques; the dialogue between key stakeholders; and finally, the organisation of waste flows and responsibility. The use of MLP and the regime-level analysis in this study are based on analogous distinction but simultaneously take into account the encompassing transforming processes and their interactions. Kivimaa and Virkamäki (2014) state that transitions are often governed by a mix of policy tools, although steering transitions is found to be a difficult and unsure proposition. In my study, attention is paid to changes that are happening due to co-evolution at different levels but also inside the regime level while they are very often influenced by top-down processes in addition to bottom-up ones. This study was designed to evaluate mainly the top-down perspective, where the lock-ins of the socio-technical regime are in focus and where landscape changes can destabilise things at the regime level. The struggles of the activities in the niche level are present only to a minor extent.

As one of the developers of MLP, Geels (2017) has presented several weaknesses of this approach, e.g. the limited assessment of sustainability outcomes or reliance on qualitative case study methods. The use of the MLP concept simultaneously includes challenges linked to delineation of the socio-technical regime (Smith et al., 2010; Markard and Truffer, 2008). Since the socio-technical regime can be understood in different ways (e.g. sectoral or technological) and the perspective can vary, Markard and Truffer (2008) state that the regime concept in empirical studies should be well-defined. This study defines the system boundary for socio-technological transition to be a change in national recycling performance in municipal waste management and a shift from linear-focused material use to sustainable and circular material use in society. Another problem with system boundaries lies also in the possible risk of making simplified interpretations over the complex processes (Smith et al., 2010). Berkhout et al. (2004) claim that one weakness of MLP is the emphasis on the bottom-up change focusing on activities in niches instead of dimensions in the socio-technical regime that work more downwards. Despite the above-mentioned weaknesses, the use of MLP is justified by the attempt to build a comprehensive picture over a complex phenomenon that would not be possible with a precise and quantitative study method.

2.2. Methods

Socio-technical transitions are often studied by using a case study. Yin (2009) states that a case study investigates a contemporary phenomenon and within its real-life context when the boundaries between phenomenon and context are not clear. The qualitative case study method is a way to increase understanding about complex transitions and the causal connections between variables (Yin, 2009). In this study, countries can be considered as multiple cases, where the purpose is to explain the complexity and characteristics of the transition in different nations. Since a transition is usually a temporally long process, this study focused on the development in the recent past (time frame 2010–2019), although some changes dating back to a longer period of time have also been observed. The case study approach also makes it possible to observe the longitudinal process (Geels, 2017).

Within the case study approach, the multiple case study method offers a way to understand the differences and similarities between cases (Baxter and Jack, 2008). Austria, Sweden and Finland can all be categorised as high-performers in waste management especially from the global point of view (UNEP, 2015). Austria is among the top performers in municipal waste recycling with a recycling rate of 58% (Eurostat, 2019). According to Eurostat (2019), Austria's recycling rate was already 50% in 1995, whereas Sweden has made progress in recycling during the last two decades. Sweden represents a good recycling performance with a recycling rate of 49%. (Avfall Sverige, 2017) reports that the amount of material collected for reuse and recycling has also increased in recent years. Finland has stable development and a moderate recycling level of 42%, whereas recycling tonnes have slowly increased along with the waste amounts. Finland has remained in the same recycling level from 1999 to 2016. In general, the waste amounts have risen and compositions of MSW have evolved in all countries over the decades, but the shares of biological treatment and material recycling have also fluctuated. For example, the growth of the MSW recycling rate is mainly due to organic recycling in Sweden. Appendix 1These countries, which to some extent are similar, were chosen to be studied because the aim is to find out whether any significant differences can be found despite the strong regulatory regime that all three countries have. Additionally, detailed waste data from these countries is available, which in turn enables a temporal perspective in the observations.

The data was gathered in two ways: through policy documents and interviews. Yin (2009) suggested using multiple sources of evidence as the means to ensure construct validity. The studied policy documents included national waste management plans and their background reports, the previous plans and the EEA's country-specific analysis of municipal waste management in 2013 and 2016 (Appendix 1.). Additional data was gathered by semi-structured interviews (Longhurst, 2003) from October 2018 to February 2019. The interviewees were authorities, researchers and actors working in the field of municipal solid waste management, and they were identified using the networks of the researcher. The interviews were recorded and transcribed. Altogether ten experts were interviewed, three interviews per country. One expert gave written answers. This number of interviews was sufficient to give an overall picture about perceptions on the most important factors influencing the transition in the case country. In many cases the experts ended up giving similar key points to most of the questions, which implies saturation of the material. Some limitations of the interviews were recognised, as the Finnish experts expressed more critical and descriptive viewpoints compared to their Austrian and Swedish colleagues because of the language used in the interviews.

A thematic analysis was used to identify themes and patterns within all research data (Braun and Clarke, 2006). Policy documents were analysed from the perspective of the socio-technical regime structure of recycling and the development in recent years. The analysis of the policy documents and the transcribed interviews was begun by identifying key factors and measures (e.g. actors, practices, solutions and processes) in different regimes, like regulations, markets, technology and infrastructure and cultural discourses, affecting the transition. Also, the connections between different regimes was observed. The experts were asked about their perceptions about the reasons for recycling, how the recycling transition has succeeded in their country, what have been the key

drivers and obstacles in steering the recycling, interactions between stakeholders, presence of markets and innovations and possible future development. Secondly, the successes and possible lock-ins were identified based on the perceptions of the interviewees. Lastly, the lock-in mechanisms (Table 1.) were further divided into economic, social and political mechanisms, according to Geels (2004).

3. Results

The regulatory regime in waste management is constantly changing and offering windows of opportunity for new practices. EU waste regulations provide the outlines for national waste policies. Additionally, member countries have set their own national waste policies which can be stricter than the EU's. Table 2 presents the key policy tools and regulations but also shows the differences between countries. Key tools are presented within the country-specific results but also in the discussion.

3.1. Austria

The interviewees identified several factors that have influenced the MSW recycling transition in recent years. The paper and metal industry have been active in recycling valuable wastes. In the 80s and 90s, general environmental concern among the public created a demand for recycling. Along with the amounts of increased waste, the limited landfill space was putting pressure towards developing other treatment options. The scarcity of some raw materials, and dependence on their importation, has lately become a driver for recycling. An ever-increasing debate on plastic waste, littering and circular economy policy is strongly influencing the regime.

Austria has carried out long-term and decisive waste policy. All interviewees emphasised the role of regulations in promoting recycling. The landfill ban, biowaste treatment policy and EPR systems were especially recognised to be the most effective policy tools. The federal waste management plan as well as provincial waste management plans are regarded as key policy tools in promoting recycling. The government has financed and supported waste management related projects and communicational activities for decades. A comprehensive waste data system, EDM, enables follow-up of different waste streams; their path from generation to treating processes. Good waste data quality also facilitates the use of effective policy tools.

National waste plan (NWP) of 2011 states that the allocation of responsibilities in MSW management is well-defined and functioning. This was supported also by the interviewees. Municipalities are responsible for the collection and treatment of mixed wastes and biowastes from households. Producers are responsible for the collection and treatment of wastes under the producer's responsibility, e.g. packaging. Other municipal waste producers (e.g. business) are responsible for organising the collection and treatment. The interviewees pointed out that the public-private-partnership is functioning well. They also considered that well-established EPR systems are one key issue in Austria's good recycling performance.

Provinces regulate municipal wastes and the waste charges, but they also have their own regulations on collections and treatment, which means more variety in organising waste management between regions. Investments in treatment plants dictate the sorting and collection system in use, e.g., co-mingled collection of recyclables leading to mechanical treatment but also source separation based collection. One interviewee pointed out that areal differences can be a strength but also a challenge. The most significant identified lock-ins are gathered in Table 3. Waste operators are debating which collection and treatment system is the most preferable. Citizens can be confused of regional differences in waste management services. Recycling rates of regions vary, which indicates that regional policies have a great impact on recycling.

Markets of certain recyclables, e.g. metals, glass and paper and cardboard, are functioning well. This is due to several reasons, such as positive value, ease of collection, long traditions of collection, and legal requirements for separate collection, among other things. However, the markets for plastic (except PET) wastes are not functioning. One interviewee pointed out that the majority of products are not designed to be recyclable, whereas there is also a lack of trust for waste-based materials. Malfunctioning markets also disturb the use of biowaste-based products. Despite the national compost ordinance, compost products are given for free. Currently, the waste field is discussing a lot of end-of-waste criteria with the hope of increasing demand.

The incineration of municipal solid wastes has increased in the last two decades, as has the number of incineration plants. In order to curb incineration, an incineration tax was introduced in 2006, which is stated to be an effective policy tool. There is also a tradition for mechanical-biological treatment (MBT) of municipal wastes, but from the perspective of recycling, MBT plants are not considered key facilities. In NWP 2011, the government considers incineration capacity to be sufficient but not excessive. However, one interviewee posited that investments into facilities (MBT and incineration) hinder attempts to improve the recycling.

Policy documents and interviews indicate that source separation of biogenic wastes has been a success in Austria. Over the past 2-3 decades, biowastes have been collected with a dense network, and treatment facilities have been established all over the country. The country's strategies of 1989 stipulated that the recycling of separately collected biowaste should primarily take place in decentralised composting plants. This led to the creation of numerous companies selling crushing, composting, screening and separation technology. The amount of home and community composting is still assessed to be significant. Interviewees additionally identified some minor challenges, e.g. the ongoing debate on whether to rely on composting or digestion and how centralised plants are disturbing small, decentralised facilities and decreasing employment. Furthermore, the composting facility in the Vienna area is being challenged by quality issues. It was stated that negative attitudes towards biowaste sorting may lead to low biowaste quality, which in turn disrupts the compost process. At the same time, significant awareness raising has taken place in recent years.

Table 1
Lock-in mechanisms in the regime level.

Lock-in mechanisms (Geels, 2017)	Economic	Social	Political
Examples	Investments in infrastructure	Old practices and mindsets of actors which stabilise a certain system or technology	Different interest groups with targets for their own favour

Table 2
Key regulations promoting recycling in Austria, Sweden and Finland in 2019

Austria	Sweden	Finland
Regulations and responsibilities		
• Regulatory levels: federal, state and municipal; • Landfill ban for organic wastes since 1996; • Extended producer responsibility (EPR) schemes for packaging, WEEE, batteries; • Packaging ordinance has targets for separate collection and recycling by materials; • Ordinance on the separate collection of biogenic waste since 1992; • Ordinance on quality requirements of composts from wastes since 2001; • Municipalities are responsible for collection and treatment of mixed waste and biowastes from households. Producers are responsible for collection and treatment of wastes under their responsibility. Producers are obliged to pay municipalities for packaging in the mixed waste. Business and services are responsible for organising the collection and treatment of their own wastes; • Nine provinces have their own regulations on collections and treatment.	• Regulatory levels; national and municipal; • Landfill ban for combustible wastes since 2002 and organic wastes since 2005; • EPR schemes for paper, packaging, WEEE, batteries, medicines. Deposit refund system for beverage packaging; • Packaging ordinance has targets for separate collection and recycling by materials; • General national recycling obligations; • Municipalities are responsible for collecting and treating mixed waste and biowastes from households and from business. Producers are responsible for collection and treatment of wastes under the producer's responsibility. • Municipal waste management regulations implement obligations in practice in regions;	• Regulatory levels; national and municipal; • Landfill ban for organic wastes since 2016; • EPR schemes for paper, packaging, WEEE, batteries. Deposit refund system for beverage packaging; • Packaging ordinance has targets for separate collection and recycling by materials; • General obligation for source separation on paper, cardboard, metal, plastic and biowaste; • Municipalities are responsible for collection and treatment of mixed waste and biowastes from households and from the municipality's own operations. Municipalities can organise the collection of mixed waste and biowastes through centralised collection or households can make a deal with the waste collection company. Packaging producers are responsible for the treatment of all packaging waste but they are also responsible for the collection of household packaging waste. Municipalities are allowed to arrange additional collection. Producers do not pay municipalities for the complementing collection. Business and services are responsible for organising the collection and treatment; • Municipal waste management obligations include detailed requirements for property-specific collection;
Economic instruments		
• Landfill tax since 1989 (in 2018: EUR 87/tonne, pretreated waste EUR 29/tonne); • Incineration tax since 2006 (in 2018: EUR 8/tonne); • Volume and emptying frequency based waste fees;	• Landfill tax since 2000 (in 2018: EUR 51/tonne); • Weight-based waste fee is in use in 30 municipalities, and volume and emptying frequency based fees in other regions.	• Landfill tax since 1996 (in 2018: EUR 70/tonne); • Volume and emptying frequency based waste fees.
Waste planning		
• National waste plans and separate strategy for recycling and waste prevention; • Duty to compile provincial waste management plans;	• The goal of the national waste management plan is that 50% of all food waste is recycled by 2018 and source separation and recycling is made easier, so that 90% of households are content with the sorting services; • Duty to compile local waste management plans;	• National waste plan until 2023 includes a 55% recycling target for MSW and 60% recycling target for biowaste;

Table 3
Identified lock-ins in Austria.

Economic:	• Investments in MBT facilities dictate the regional sorting and collection system • Substantial capacity for incineration • Markets for recyclables are malfunctioning; lack of plastic recycling technology (not PET)
Social:	• Waste experts debate over treatment methods of biowaste • In Vienna, biowaste collection is a challenge in bigger buildings due to lack of services but also quality problems • Regionally different recycling systems are occasionally causing doubts among citizens • Lack of trust in waste-based products
Political:	• Variety in federal legislation and local implementation contributes to the variety in recycling performance

It was also pointed out that there is social pressure in the countryside to sort wastes and compost.

All interviewees identified a lot of good practices in waste management, e.g. good public-private co-operation in EPR schemes and a high level of academic research in the waste field. A popular collection system for cell phones (Ö3-Wundertüte) is an example of successful co-operation.

3.2. Sweden

There were traditions for recycling paper and metal in Sweden long before the existence of waste legislation. Valuable materials have been recovered as materials of new products. Despite favourable sorting habits in the past, all the interviewees stated that the most significant driver in recycling has been legislation. According to the interviewees, the EU's waste and circular economy policy, and to some extent also the environmental movement in the 80s and 90s and the plastic waste debate, have put pressure on the development of Swedish waste management in recent years. One interviewee pointed out the significance of waste prevention, such as the avoidance of food waste, when identifying key drivers in today's waste management.

Policy tools such as the landfill ban, landfill tax, EPR regulations and national and municipal waste management plans were considered to be key drivers in increasing the recycling by interviewees, whereas NWP for years 2012–2017 implies that the landfill tax has not had any proven positive effect on recycling. Policy documents indicate that there is significant national ambition in promoting recycling, e.g. stricter recycling targets in packaging EPR. Currently, municipalities are responsible for household waste and similar waste to that, while the producers for each product group have their waste included in their producer responsibility, and other waste owners are responsible for all other waste. NWP states that uncertainties in the responsibilities have

Table 4
Identified lock-ins in Sweden.

Economic:	• Overcapacity for incineration
	• Biowaste products need support from the government in order to increase their demand
	• Demand for Swedish biogas is disrupted by biogas export from Germany and Denmark
	• Recycling technology is still undeveloped or too expensive for certain materials (e.g. plastics, textiles, bulky wastes), which raises the prices of recycled materials
	• Markets for recyclables are malfunctioning
Social:	• Sorting performance is weaker in bigger houses compared to villas
	• Citizens can get confused about regionally different collection systems and terms
Political:	• Conflicts on MSW responsibilities occur to some extent at the national and political level, but not at the local operational level
	• Tax on incineration and chemical fertilisers has been abolished
	• Experts are worried that recycling does not promote clean cycles

caused some collaboration problems between the municipalities and the producers (Table 4). According to a law renewal from 2019, producers are also responsible for the collection of packaging waste and paper straight from properties. Two interviewees considered the renewed responsibilities to be clear and well-defined, although the contradictory discussion was supposed to continue. The circle of key players, e.g. municipalities, producers and other waste holders, appears to be compact. One Swedish waste expert assessed that packaging and bulky waste play a key role in increasing the recycling rate.

The interviewees highlighted that Sweden currently has overcapacity for incineration. A tax on incineration was introduced in 2006 in order to increase recycling, but it was cancelled in 2010 due to its weak effectiveness. However, the tax is being discussed again because the national climate policy demands decreasing incineration of fossil-based plastic. NWP for years 2018–2023 states that the import of waste for incineration has increased substantially in recent years. One interviewee said that municipalities consider incineration to be an enabler of clean cycles, whereas private companies claim that incineration steals recyclables from them.

The recycling of biowaste was stated to represent a success in waste management resulting from the ambitious national target. The interviewees stated that many municipalities are strongly committed to increase biowaste collection and treatment. This has created a lot of industry, technical companies, new technologies and business for consultants around the biowaste sector. Composting as a treatment method has decreased, whereas a wide network of digestion plants and markets for digestates have been created with the help of a certification system. However, it was noted that governmental support is continuously needed to boost the market of biowaste-based products; likewise, the demand for biogas was considered to be another important driver. According to NWP 2018–2023, the competition posed by imported biogas from Denmark and Germany hinders the expansion of digestive capacity. Additionally, NWP 2012–2017 stated that the removal of a tax on chemical fertilisers has had a negative impact on the marketing of digestates. Nevertheless, one interviewee pointed out that digestates are an important product for organic farming.

According to the interviewees, the national recycling target for biowaste and municipal waste management plans have been strong drivers for recycling. Municipalities in Sweden are committed to recycling and they can issue local regulations on the management of household waste, including fees. Recycling is promoted through regionally different collection and treatment systems, e.g. an optical sorting system for coloured waste bags, multilocker collection or weight-based waste fees. Collaboration between municipalities in organising waste management services is functioning well and has led to cost-efficiency in waste management. Waste advice is provided with the co-operation between municipal waste companies and producers, which has created positive sentiment towards recycling. NWP 2012–2017 indicates that households have been increasingly (from 2006 to 2011) content with the service level of sorting possibilities. However, it also stated that products not designed for recycling are still challenges for recycling.

Only a few social lock-ins were identified, e.g. sorting habits in bigger houses can be inadequate. Citizens can get confused over the regionally different collection systems. While the interviewees stated that high citizen awareness on recycling puts pressure on the regime, they furthermore agreed that the majority of Swedish citizens are extremely willing to sort their wastes.

It was not only public operators who were identified as being innovative. It was mentioned that the furniture company IKEA has recently started initiatives to promote recycling, which can have a positive impact on both recycling markets and the awareness of citizens. It was also pointed out that many private companies are demanding stricter recycling targets.

3.3. Finland

Both NWP for years 2008–2016 and the interviewees posited that EU waste and circular economy policies have been the main drivers behind the development in waste management. In recent decades, the variety of landscape-level pressure on waste management has been limited. Paper and metal recycling practices were adopted after World War II when the Finns were obliged to use materials economically.

The interviewees highlighted a considerable amount of political, economic and also social lock-ins in recycling transition. The identified lock-ins are compiled in Table 5 in order to enable a full picture of the different obstacles. Constantly shifting legislation has created an unwillingness to invest in recycling. The division of responsibilities in MSW was mentioned as the main political lock-in regulatory regime. It was presented that fragmented responsibilities in MSW management have led to a partial optimisation of profits in waste management in the absence of an attempt at building the big picture. Additionally, the dual system in organising waste collection from households complicates the recycling e.g. by hampering data collection and supervision but also by increasing the administrational burden. However, one interviewee said that conflicts on responsibilities occur most often at the national and political level, not so much at the local level. Another identified political lock-in was linked to the costs of waste collection. There is political pressure to keep the waste fees low, which has affected the moderate development in increasing collection from properties.

As an economic lock-in, interviewees stated that markets for many recyclables are defective and the demand for materials is weak. The situation is sustained because Finland is geographically isolated from the European material markets. A future challenge lies in the upcoming investments into new incineration plants, while some interviewees considered this to threaten the recycling development. However, municipal waste operators consider that

Table 5
Identified lock-ins in Finland.

Economic:	• Finland is geographically isolated from the European material markets • Markets for recyclables are malfunctioning • Incineration capacity and low incineration gate fees • The existing waste data system is inadequate
Social:	• Sorting performance is weaker in bigger houses compared to villas • Resistance to change within the waste sector hinders piloting novelties • The LCA studies in local waste management have restricted the property-specific collection • Citizens can get confused about different operators organising waste collections, regionally different systems and terms in MSW • Waste advice is inadequate from region to region • Co-operation between key players is inadequate
Political:	• Responsibilities in MSW have been changed many times over the past few years. Changes in legislation have created uncertainty and led to an unwillingness to invest. Fragmented responsibilities have led to partial optimisation in waste management. Conflicts on MSW responsibilities occur to some extent at the national level, but not at the operational level • The dual system in organising waste collection from households hinders effective recycling e.g. by making data collection and supervision challenging • Local decision-makers value low waste fees instead of improvement of the collection services that could increase costs

there is still some need for incineration capacity, as mixed waste is exported for energy recovery to neighbouring countries. Incineration was also considered to be an economically viable but also "easy" treatment option compared to recycling. At the same time, markets for recycled materials like compost products and digestates are malfunctioning.

Only a few technological lock-ins were identified. The public waste data system is inadequate and does not enable high-quality planning of MSW management. This was considered to be a significant hindrance in improving recycling. According to NWP 2017–2023 (background report), composting is still the most common system for treating biowastes even though the amount of digestion plants is steadily increasing. In the beginning of 2000, biowaste recycling suffered from technical obstacles. However, interviewed waste experts agreed that biowaste is the most potential waste stream from the viewpoint of increasing recycling. Currently there is a growing interest towards plastic recycling, and a few facilities have received investment. The textile sorting and recycling technology and business is also under development, and promising innovations have been created.

Finland's municipal solid waste management is not without its success elements. NWP and the interviewees pointed out that municipalities have succeeded well in organising the municipal waste management. Large municipalities introduced biowaste collection from apartment buildings already a couple of decades ago. Also, PAYT principals have been in use for a long time nationwide. According to the interviewees, it can be seen that a growing number of citizens want to recycle, which is putting pressure on waste management. Even though awareness is rising, many are still not sorting their wastes.

Also, social lock-ins within the practices of waste operators was identified. The interviewees stated that waste advice is still inadequate. Although municipalities play a key role in promoting household recycling, they have restricted the increase of property-specific recyclable collection on the basis of LCA studies in local waste management.

Research and development in cleantech has been a success story in Finland. The government supports both investments and research and development of clean technologies. Technical innovations in sorting and collection have been created, but their impact on recycling has been moderate. One reason may be the like-minded thinking within the waste sector that may have challenged the adaption of new practices. One interviewee pointed out that the waste expertise of local decision-makers is not necessarily on a high level.

At the moment, the waste sector is discussing responsibilities, plastics, cost-efficiency and the environmental impacts of recycling. An internet-based advice service on sorting sites and a deposit refund system for beverage packaging were considered to demonstrate good co-operation examples between public and private actors. Only a few promising niche activities were identified. A Finnish company, ST1, which produces ethanol out of certain biowaste streams has boosted recycling, as the resulting digestate from the process is used as fertiliser. There are also high hopes that Finland will be a forerunner in the textile recycling industry. Municipalities are quite commonly co-operating with local companies by providing suitable space for their recycling activities and enabling circular business in their area.

4. Discussion

The first research question asks what are the characteristics that represent the MSW recycling transitions in Austria, Sweden and Finland. My results show that while EU legislation has been a significant driver in waste management, national waste policy and regulations with its delineations of responsibilities, the variety of infrastructure and collection systems in waste management, the level of general awareness, public-private co-operation and accuracy of the national waste data also act as key characteristics that mirror the success in recycling. The purpose of the second research question is to identify the country-specific lock-ins for recycling. According to the results, all countries have political, economic and social lock-ins, but Finland seems to have slightly stronger ones compared to the others. Some lock-ins are common for all, such as incineration capacity, lack of product design for recyclability or malfunction of markets of recyclables. The third question was about the differences in transition paths. These countries are in different temporal phases. Austria began to promote recycling long before Finland, and there has been a stronger landscape-level pressure. The number of identified lock-ins also expresses the significance of the rigid waste management regime which does not easily allow new innovations or practices to emerge.

Waste legislation plays a key role in transition in MSW management (Silva et al., 2017; Lauridsen and Jørgensen, 2010). The comparison of regulatory tools (Table 2) demonstrates that there are some major differences between the studied countries. Austria has an incineration tax in use unlike Finland and Sweden. Also, alongside the policy instruments, the ambition level in promoting composting and biogas production have been very high in Austria and Sweden. Another key difference lies in organising the EPR system for packaging, because they (carton, metal, glass, plastic) represent key waste streams from the perspective of recycling performance. Austria has set clear responsibilities in organising packaging waste management but also introduced an EPR, where producers are fully responsible for organising the collection of packaging, while also obligated to pay municipalities for treating

packaging. In Finland, the responsibilities in EPR are divided among different actors. Other drivers exist, as the recycling of packages has been steered by the economic value of materials and industry interest, but lately plastic littering has also been debated. Additionally, the federal legislation and further implementation at the local level has contributed to the variety in regional recycling performance in Austria. Countries struggling with recycling performance should make more use of the policy measures of forerunner countries (Table 2). This conclusion is also supported by Expósito and Velasco (2018).

The responsibility of municipalities to collect and manage wastes is largely 'taken for granted' in the EU, and the shift to environmentally sound waste management has led to inter-municipal co-operation, especially, to realise economies of scale (Wilson, 2007). Unlike most other European countries, Finland is an exception as household waste collection can also be organised by waste holders. In Sweden, the share of MSW responsibilities has likewise been identified as a lock-in, but not so strongly. Geels (2002) states that elements in the regime level are stable because they are linked together. This is reflected in the responsibilities in MSW in Finland, where identified political lock-ins are simultaneously connected to the regulatory, economic and social regime and changes have been almost impossible to accomplish. However, the division of responsibilities should be combined with clear targets (e.g. Austria). Therefore, systems where targets cannot be directed to certain actors and followed cannot be effectively carried out. Duygan et al., 2018 studied discourse coalitions in waste management and found that, despite an incoherent regime with different belief clusters on core issues in waste management, the transitions can be initiated at the local or regional scale by utilising shared interest e.g. treatment of plastics. Many Finnish experts suggested that political disputes arise only at the national level, not so much at the regional, operational level. Therefore, solving the responsibility challenges could benefit the bottom-up approach, involving also the local operators in the process. Additionally, a strong co-operation between different actors was found to be a key element in successful recycling. Forbord and Hansen (2020) call attention to the importance of learning the actors in the transition process.

This study points out the relevance of decreasing the incineration, similarly to Milios et al. (2019), in reaching higher recycling levels. However, Malinauskaite et al. (2017) have emphasised the importance of incineration and energy recovery also in a circular economy. Incineration capacity has been established not only to decrease the landfilling of organic wastes and generation of negative climate impacts of landfilling but also to gain synergy from combining waste management and energy production (Malinauskaite et al., 2017). Landfilling is no longer a vital treatment method for MSW in Austria, Sweden and Finland. Furthermore, (Huysveld et al., 2019) indicate that the environmental benefits from recycling of many waste fractions (especially plastics) are bigger than from incineration. Incineration as a dominant treatment method is difficult to change because of the existing economic (investments in facilities and agreements between waste dealers and facilities) and political lock-ins (interests of certain waste operators). It would also require changes in the current energy regime. So far, the challenge of overcapacity seems to complicate Finland the least out of all the studied countries.

According to the results, the environmental awareness and will for sorting is strong in Sweden and Austria. This is in line with the results of Miliute-Plepiene et al. (2016), as they found that convenience, as well as social norms, have the most significant influence on high recycling behaviour. Also, Xiao et al. (2017) highlight the significance of local level and public participation in waste management. Strong policy mixed together with active citizens and a growing number of investments in recycling technology has inspired the development both in Austria and in Sweden. Accordingly, Wilson (2007) has categorised the drivers for waste management and states that there is not a single driver that is dominant, and drivers vary in different countries. However, national policy measures and the top-down approach is challenged by Taelman et al. (2018), as they state that municipal level decision-making and the ambition level are very important and can lead to success. On the other hand, Read (1999) warns that the decentralisation of waste management to local authorities can lead to problems if the implementation of national waste plan is carried out without sufficient budgetary resources. Whereas Finland and Sweden both have strong co-operation between municipalities in waste management, only Sweden implements municipal waste management plans that are strongly steering the local operations. The views of interviewees undoubtedly reflect this as interviewees agreed that municipalities in Sweden are very ambitious in their waste management. Meanwhile Silva et al. (2017) note that traditional governance under municipal responsibility is driven by cost-efficiency, which hinders promoting ambitious material management. Political, economic and social elements are once again tied strongly together.

Good data systems and waste accounting are needed in order to choose the suitable policy instruments (Paul and Bussemaker, 2020; Taelman et al., 2018; Tisserant et al., 2017). This is strongly supported by this study. Appropriate data management could further enable co-evolution between e.g. regulatory (setting new policy tools) and cultural (acceptance and positive mindset towards recycling activities) regimes. It seems that data system development is a significant way to steer the transition at the governmental level. This study confirms the common concern of the difficulty in reaching the upcoming recycling targets that seems to be lacking closer examination of the need for waste prevention, safe cycles, resource efficiency, climate impact and the whole systemic change towards CE. Continuous increase of the waste recycling as one part of the circular economy palette has also been criticised by Fellner et al. (2017) and Ghisellini et al. (2016).

As previously stated, many lock-ins at the regime level cover both local and national bottlenecks. Hogg et al. (2018) see that solutions to problems need actions from the government, municipalities and also citizens. In Austria, the overcapacity in incineration, nonfunctional markets of recyclables or variety in local implementation leading to uneven recycling performance of regions may all need governmental intervention. The last point is in line with the suggestion of the EU Commission regarding the need to harmonise the separate waste collection systems (EU Commission, 2019). Hogg et al. (2018) add that national policy ought to ensure that local and regional actors are incentivised to act and implement the waste policy. Similarly to Austria, Sweden suffers from overcapacity in incineration and has a weak market for recyclables, and support from government is suggested by the interviewees as both lock-ins connect to the current energy policy e.g., discussion on tax for incineration, climate policy, import of biogas. As Sweden has challenges in biowaste sorting in the high-rise buildings, Hogg et al. (2018) state that municipalities have a key role in developing systems that capture high amount of recyclables in high-rise buildings but also citizens should have incentives to sort their wastes. Further Lindqvist (2012) states that Sweden's waste governance has been influenced by conflicting legislation, planning in urban areas and also long-range investments where municipalities' dominance and operative role is significant, for example.

Bottlenecks in Finland are connected to deficiencies in legislation e.g., fragmented responsibilities and in data systems but also to local level decision making and operative waste management. As in

Sweden, there is a strong need for incentives to recycle in Finland and encouragement of actors would also be a solution for negative attitudes and stiff beliefs that may hinder recycling activities. Hogg et al. (2018) agree that countries like Finland, where recycling schemes are disconnected from operators that are responsible for collection and treatment of mixed wastes, the EPR schemes do not gain any benefits from reduced mixed waste amounts. Therefore, EPR schemes and waste services should be integrated and responsibilities made clearer and integrated through regulatory measures.

The variety of landscape pressures has changed the waste management regime over time in Europe. However, not every country faces the same strains, e.g. Finland and Sweden have not lacked landfill space. Some of the external factors influencing the regime are common to all such as the debate on plastic wastes. The waste recycling regime is also commonly burdened by the weak demand of non-valuable recyclables. This is again supported by Fellner et al. (2017), who state that recycling in the EU is challenged by growing recyclable stocks with low quality. In this study, some of the identified success factors of recycling can be considered as niche innovations, e.g., PET recycling, communication tools, co-operation between waste operators or data management. However, Zhang et al. (2019) state that the barriers hindering the implementation of smart and innovative waste management are numerous. True niche innovations in MSW recycling needs further studies since recycling is most commonly managed top-down using regulations.

5. Conclusions and policy implications

This study demonstrates that there are different pathways to a high-performing MSW recycling society, even though the comparison of countries does not provide easy insights or clear solutions for taking the next steps.

The main contribution of this study is to highlight the variety of different elements that are affecting the transition in the studied countries over recent years.

Recycling markets are not limited to the borders of one country, while the political will to establish national economic incentives for the use of recycled plastic, for example, may be too weak. Identified economic lock-ins are mainly common to all studied countries, e.g., the malfunction of markets for recyclables and excessive incineration capacity. Therefore, these challenges should be tackled at the level of EU policy.

Many social and political lock-ins differ country-specifically depending on the operational environment and historical development. Strong co-operation between key operators but also operators in national, regional and local levels can diminish existing lock-ins, whereas beliefs and old practices can hinder recycling. A positive mindset towards recycling initiatives was considered to be a success factor in recycling. Also, more emphasis should be given to the exchange of information on good practices, e.g. the use of weight-based waste fees, innovative waste collection systems, new ways of doing co-operation and effective advising, green deals in waste management, recycling certificates and innovative recycling technologies between countries. In addition, new innovations on recycling technology are still needed e.g. for plastics.

Success in recycling of municipal wastes needs both usage of different policy tools and actions for governmental and local level by introducing incentives to making the changes more appealing. Local level governance and activities are of particular significance and countries should pay more attention to resources and know-how of the local actors. Responsibility questions seem to be relevant in increasing collection and recycling MSW. Solving the disputes between private and public waste management operators needs extra consideration, bottom-up approaches and support from global and multidisciplinary research on the role of responsibilities in increasing recycling. This challenge concerns countries like Finland, where the responsibilities are fragmented.

Transitions take time, therefore sudden and constant changes in legislation should be avoided. Furthermore, models of innovative governance based on co-operation and voluntary action should be studied. Also, research on critical assessment of ambitious recycling targets is needed, as waste experts declare their concern of their appropriateness from the viewpoint of non-risky cycles and other possible negative environmental impacts resulting from material losses from recycling and downcycling.

CRediT authorship contribution statement

Hanna Salmenperä: Conceptualization, Methodology, Investigation, Writing - original draft, Writing - review & editing.

Declaration of competing interest

The author declare that she has no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

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References

Avfall Sverige, 2017. Swedish Waste Management 2017. Accessed 20.4.2019. Retrieved from: https://www.avfallsverige.se/.

Baxter, P., Jack, S., 2008. Qualitative case study methodology: study design and implementation for novice researchers. Qual. Rep. 13 (4), 544–559. Retrieved from. https://nsuworks.nova.edu/tqr/vol13/iss4/2.

Berkhout, F., Smith, A., Stirling, A., 2004. Socio-technological regimes and transition contexts. In: Elzen, B., Geels, F.W., Green, K. (Eds.), System Innovation and the Transition to Sustainability: Theory, Evidence and Policy. Edward Elgar, Cheltenham, pp. 48–75.

Biyani, N., Anantharaman, M., 2017. Aligning stakeholder frames for transition management in solid waste: a case of Bangalore. International development policy. Rev. Int. Polit. Développement 8 (2). https://doi.org/10.4000/poldev.2483, 2017.

Braun, V., Clarke, V., 2006. Using thematic analysis in psychology. Qual. Res. Psychol. 3 (2), 77–101. https://doi.org/10.1191/1478088706qp063oa.

Buclet, N., Godard, O., 2001. The evolution of municipal waste management in Europe: how different are national regimes. J. Environ. Pol. Plann. 3 (4), 303–317. https://doi.org/10.1002/jepp.91.

Duygan, M., Stauffacher, M., Meylan, G., 2020. What constitutes agency? Determinants of actors' influence on formal institutions in Swiss waste management. Technol. Forecast. Soc. Change 162, 120413. https://doi.org/10.1016/j.techfore.2020.120413.

Duygan, M., Stauffacher, M., Meylan, G., 2018. Discourse coalitions in Swiss waste management: gridlock or winds of change? Waste Manag. 72, 25–44. https://doi.org/10.1016/j.wasman.2017.11.006.

EEA, 2013. Managing municipal solid waste — a review of achievements in 32 European countries. EEA Report 2.

EEA, 2018. Recycling of municipal waste. Briefing published 29 November 2018, last modified 26 November 2019. Accessed 18.12.2019. https://www.eea.europa.eu/airs/2018/resource-efficiency-and-low-carbon-economy/recycling-of-municipal-waste.

EU Commission, 2019. Communication from the Commission. The European Green Deal, Brussels, 11.12.2019 COM(2019) 640 final.

Eurostat, 2019. Recycling rate of municipal waste. Accessed 17.6.2019. https://ec.europa.eu/eurostat/web/products-datasets/product?code=sdg_11_60.

Expósito, A., Velasco, F., 2018. Municipal solid-waste recycling market and the European 2020 Horizon Strategy: a regional efficiency analysis in Spain. J. Clean. Prod. 172, 938–948. https://doi.org/10.1016/j.jclepro.2017.10.221.
Fellner, J., Lederer, J., Scharff, C., Laner, D., 2017. Present potentials and limitation of a circular economy with respect to primary raw material demand. J. Ind. Ecol. 21 (3), 494–496. https://doi.org/10.1111/jiec.12582.
Forbord, M., Hansen, L., 2020. Enacting sustainable transitions: a case of biogas production and public transport in Trøndelag, Norway. J. Clean. Prod. 254, 120156. https://doi.org/10.1016/j.jclepro.2020.120156.
Geels, F.W., 2002. Technological transitions as evolutionary reconfiguration processes: a multilevel perspective and a case study. Res. policy 31 (8–9), 1257–1274. https://doi.org/10.1016/S0048-7333(02)00062-8.
Geels, F.W., 2004. From sectoral systems of innovation to socio-technical systems: insights about dynamics and change from sociology and institutional theory. Res. Pol. 33 (6–7), 897–920. https://doi.org/10.1016/j.respol.2004.01.015.
Geels, F.W., 2017. Socio-technical transitions to sustainability. In: Perspectives on Transitions to Sustainability. EEA Report 25/2017. European Environment Agency, pp. 45–69.
Geels, F.W., Schott, J., 2007. Typology of socio-technical transition pathways. Res. policy 36, 399–417. https://doi.org/10.1016/j.respol.2007.01.003.
Geyer, R., Kuczenski, B., Zink, T., Henderson, A., 2015. Common misconceptions about recycling. J. Ind. Ecol. 20 (5), 1010–1017. https://doi.org/10.1111/jiec.12355.
Ghisellini, P., Cialani, C., Ulgiati, S., 2016. A review on circular economy: the expected transition to a balanced interplay of environmental and economic systems. J. Clean. Prod. 114, 11–32. https://doi.org/10.1016/j.jclepro.2015.09.007.
Haas, W., Krausmann, F., Wiedenhofer, D., Heinz, M., 2015. How circular is the global economy? An assessment of material flows, waste production, and recycling in the European Union and the world in 2005. J. Ind. Ecol. 19 (5), 765–777. https://doi.org/10.1111/jiec.12244, 2015.
Hansen, W., Christopher, M., Verbuecheln, M., 2002. EU Waste Policy and Challenges for Regional and Local Authorities. Background Paper for the Seminar on Household Waste Management "Capacity Building on European Community's Environmental Policy" 1–19.
Hogg, D., Elliott, T., Burgess, R., Vergunst, T., 2018. Study to identify member states at risk of non-compliance with the 2020 target of the waste framework directive and to follow-up phase 1 and 2 of the compliance promotion exercise. Final Report. https://ec.europa.eu/environment/waste/framework/pdf/Early%20Warning%20System_Final_Report.pdf.
Huysveld, S., Hubo, S., Ragaert, K., Dewulf, J., 2019. Advancing circular economy benefit indicators and application on open-loop recycling of mixed and contaminated plastic waste fractions. J. Clean. Prod. 211, 1–13. https://doi.org/10.1016/j.jclepro.2018.11.110.
Jackson, M., Lederwasch, A., Giurco, D., 2014. Transitions in theory and practice: managing metals in the circular economy. Resour. 3, 516–543. https://doi.org/10.3390/resources3030516.
Joseph, K., 2006. Stakeholder participation for sustainable waste management. Habitat Int. 30 (4), 863–871. https://doi.org/10.1016/j.habitatint.2005.09.009.
Karakaya, E., Nuur, C., Assbring, L., 2018. Potential transitions in the iron and steel industry in Sweden: towards a hydrogen-based future? J. Clean. Prod. 195, 651–663. https://doi.org/10.1016/j.jclepro.2018.05.142.
Kivimaa, P., Virkamäki, V., 2014. Policy mixes, policy interplay and low carbon transitions: the case of passenger transport in Finland. Env. Policy and gov. 24 (1), 28–41. https://doi.org/10.1002/eet.1629.
Lauridsen, Jorgensen, 2010. Sustainable transition of electronic products through waste policy. Res. policy 39 (4), 486–494. https://doi.org/10.1016/j.respol.2010.01.021.
Le, N.P., Nguyen, T.T.P., Zhu, D., 2018. Understanding the stakeholders' involvement in utilizing municipal solid waste in agriculture through composting: a case study of hanoi, vietnam. Sustain. Times 10, 2314. https://doi.org/10.3390/su10072314.
Lindqvist, K., 2012. Hybrid Governance: the case of household solid waste management in Sweden. In: Paper Presented at IRSPM Annual Conference - XVI - University of Rome Tor Vergata 2012: "Contradictions in Public Management. Managing in Volatile Times".
Longhurst, R., 2003. Semi-structured interviews and focus groups. In: Clifford, N.J., Valentine, G. (Eds.), Key Methods in Geography. Sage, London, pp. 117–132.
Lozano Lazo, D.P., Gasparatos, A., 2019. Sustainability transitions in the municipal solid waste management systems of Bolivian cities: evidence from La paz and santa cruz de la Sierra. Sustainability 11, 4582.
Malinauskaite, J., Jouhara, H., Czajczyńska, D., Stanchev, P., Katsou, E., Rostkowski, P., Thorne, R.J., Colón, J., Ponsá, S., Al-Mansour, F., Anguilano, L., Krzyżyńskac, R., López, I.C., Vlasopoulos, A., Spencer, N., 2017. Municipal solid waste management and waste-to-energy in the context of a circular economy and energy recycling in Europe. Energy 141, 2013–2044. https://doi.org/10.1016/j.energy.2017.11.128.
Markard, J., Raven, R., Truffer, B., 2012. Sustainability transitions: an emerging field of research and its prospects. Res. Pol. 41 (6), 955–967. https://doi.org/10.1016/j.respol.2012.02.013.
Markard, J., Truffer, B., 2008. Technological innovation systems and the multi-level perspective: towards an integrated framework. Res. Pol. 37 (4), 596–615. https://doi.org/10.1016/j.respol.2008.01.004.
Massaud, M.A., Mokbel, M., Alawieh, S., Yassin, N., 2019. Towards improved governance for sustainable solid waste management in Lebanon: centralised vs decentralised approaches. Waste Manag. Res. 37 (7), 686–697. https://doi.org/10.1177/0734242X19836705.
Milios, L., Holm Christensen, L., McKinnon, D., Christensen, C., Rasch, M.K., Hallstrøm Eriksen, M., 2019. Plastic recycling in the Nordics: a value chain market analysis. Waste Manag. 76, 180–189. https://doi.org/10.1016/j.wasman.2018.03.034.
Miliute-Plepiene, J., Hage, O., Plepys, A., Reipas, A., 2016. What motivates households recycling behaviour in recycling schemes of different maturity? Lessons from Lithuania and Sweden. Resour. Conserv. Recycl. 111, 40–52. https://doi.org/10.1016/j.resconrec.2016.05.008Miliute-Plepiene 2016.
Nowakowski, P., Mrówczyńska, B., 2018. Towards sustainable WEEE collection and transportation methods in circular economy – comparative study for rural and urban settlements. Resour. Concerv. Recycl. 135, 93–107. https://doi.org/10.1016/j.resconrec.2017.12.016.
Paul, M., Bussemaker, M.J., 2020. A web-based geographic interface system to support decision making for municipal solid waste management in England. J. Clean. Prod. 263, 121461. https://doi.org/10.1016/j.jclepro.2020.121461.
Raven, Rob, 2007. Co-evolution of waste and electricity regimes: multi-regime dynamics in The Netherlands (1969–2003). Energy Pol. 35 (4), 2197–2208. https://doi.org/10.1016/j.enpol.2006.07.005.
Read, A.D., 1999. Making waste work: making UK national solid waste strategy work at the local scale. Resour. Conserv. Recycl. 26 (3–4), 259–285. https://doi.org/10.1016/S0921-3449(99)00015-4.
Salmenperä, H., Pitkänen, K., Kautto, P., Saikku, L., 2021. Critical factors for enhancing the circular economy in waste management. J. Clean. Prod. 280 (1), 124339. https://doi.org/10.1016/j.jclepro.2020.124339.
Savini, F., 2019. The economy that runs on waste: accumulation in the circular city. J. Environ. Pol. Plann. 21 (6), 675–691. https://doi.org/10.1080/1523908X.2019.1670048.
Silva, A., Rosano, M., Stocker, L., Gorissen, L., 2017. From waste to sustainable materials management: three case studies of the transition journey. Waste Manag. 61, 547–557. https://doi.org/10.1016/j.wasman.2016.11.038.
Singh, J., Ordoñez, I., 2016. Resource recovery from post-consumer waste: important lessons for the upcoming circular economy. J. Clean. Prod. 134, 342–353. https://doi.org/10.1016/j.jclepro.2015.12.020.
Smith, A., Voß, J.-P., Grin, J., 2010. Innovation studies and sustainability transitions: the allure of the multi-level perspective and its challenges. Res. Pol. 39 (4), 435–448. https://doi.org/10.1016/j.respol.2010.01.023.
Stahel, W.R., 2016. The circular economy. Nature 531, 435–438. https://doi.org/10.1038/531435a.
Taelman, S., Tonini, D., Wandl, A., Dewulf, J., 2018. A holistic sustainability framework for waste management in European cities: concept development. Sustainability 10 (7), 2184. https://doi.org/10.3390/su10072184.
Taleb, M.A., Al Farooque, O., 2021. Towards a circular economy for sustainable development: an application of full cost accounting to municipal waste recyclables. J. Clean. Prod. 280 (2), 124047. https://doi.org/10.1016/j.jclepro.2020.124047.
Tisserant, A., Pauliuk, S., Merciai, S., Schmidt, J., Fry, J., Wood, R., Tukker, A., 2017. Solid waste and the circular economy: a global analysis of waste treatment and waste footprints. J. Ind. Ecol. 21 (3), 628–639. https://doi.org/10.1111/jiec.12562.
Unep, 2011. Decoupling Natural Resource Use and Environmental Impacts from Economic Growth, A Report of the Working Group on Decoupling to the International Resource Panel. Fischer-Kowalski, M., Swilling, M., von Weizsäcker, E.U., Ren, Y., Moriguchi, Y., Crane, W., Krausmann, F., Eisenmenger, N., Giljum, S., Hennicke, P., Romero Lankao, P., Siriban Manalang, A., Sewerin, S.
Unep, 2015. Global Waste Management Outlook. UNEP & ISWA. United Nations Environment Programme.
Wilson, D.C., 2007. Development drivers for waste management. Waste Manag. Res. 25 (3), 198–207. https://doi.org/10.1177/0734242X07079149.
de Wit, M., Hoogzaad, J., Ramkumar, S., Friedl, H., Douma, A., 2018. The Circularity Gap Report - an Analysis of the Circular State of the Global Economy. January 2018. Circle Economy. https://shiftingparadigms.nl/wp-content/uploads/2017/11/the-circularity-gap-report-2018.pdf.
Xiao, L., Zhang, G., Zhuc, Y., Lin, T., 2017. Promoting public participation in household waste management: a survey based method and case study in Xiamen city, China. J. Clean. Prod. 144, 313–322. https://doi.org/10.1016/j.jclepro.2017.01.022.
Yin, R.K., 2009. Case study research. Design and Methods. In: Applied Social Research Methods Series, fourth ed., vol. 5. Sage Publications, ISBN 978-1-4129-6099-1.
Zhang, A., Venkatesh, V.G., Liu, Y., Wan, M., Qu, T., Huisingh, D., 2019. Barriers to smart waste management for a circular economy in China. J. Clean. Prod. 240, 118198. https://doi.org/10.1016/j.jclepro.2019.118198.