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WASTE, A MATTER OF ENERGY. A DIACHRONIC ANALYSIS (1992-2017) OF WASTE-TO-ENERGY RATIONALES

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Commonly referred to as *waste-to-energy*, the utilisation of energy generated by waste treatment processes is meeting unprecedented interest in terms of the amount of energy recovered and the diverse ways of doing it. Although incineration remains the most widespread waste-to-energy technology,[1] other solutions are diverse and becoming more common. Climate and energy policies, set at European and national levels, have contributed to the adoption of energy recovery as an alternative to fossil fuels. Waste-to-energy policies have been strengthened, by means of a combination of legal frameworks, public support and incentives, to the extent that waste management can be considered to be partly driven by climate and energy concerns. Since it seems that the public policies governing waste management are increasingly being determined by energy matters, this chapter aims to test the hypothesis *the energy shaping of waste*. If waste-to-energy now falls under the jurisdictions of both waste management and energy, it will be necessary to identify when and where the convergence of these two agendas originates, as well as the very framing processes they rely on.

This chapter focuses on energy-from-waste at the policymaking level in Europe and its implementation in France, in order to grasp how, in these contexts, waste has become an energy issue. Based on an analysis of the last three decades, it aims to investigate to what extent and by what means energy recovery from waste has been conducted and debated. The

[1] 'According to a study by the Commission, in 2014 approximately 1.5% of the EU's total final energy consumption was met by recovering energy from waste through incineration, co-incineration in cement kilns and anaerobic digestion (i.e. around 676 PJ/year)' (European Commission 2017, 8).

investigation of specific instruments (including fiscal and financial incentives, regulatory tools, accountancy and technical standards), through which waste policy is not only implemented but also framed as a social issue, offers a fruitful insight into waste-to-energy rationales. It allows an understanding of policy choices, outcomes, and competing or conflicting issues, as well as the ongoing debates that waste-to-energy is facing. Controversies have proven to be an important aspect of the framing and debating of energy waste related issues, since energy recovery was the main reason that incineration gained legitimacy while simultaneously being challenged.

This analysis has been conducted by scrutinising official releases, technical or lobbying documents and discourses, and supplemented by interviews with actors from institutions, industries and NGOs relating to waste-to-energy issues. It outlines the situation as it evolved from the early 1990s and on as this period corresponds to the intensification of waste policies, on the one hand, and to the setting of a climate agenda, on the other, both in Europe and France. Two pieces of European policy, i.e. the 2008 EU Waste Framework Directive and a 2017 Communication by the European Commission on ‘The role of waste-to-energy in the circular economy’, albeit of differing status and incidence, are significant milestones. As these represent attempts to place energy recovery in a *hierarchy*, they reflect the competing issues to be found in waste-to-energy processes and explain much of the change that has occurred. This analysis is organised in terms of two periods: The setting of an energy recovery policy, as a result of climate and waste converging agendas (1992-2008), and its evolution when having to deal with multiple energy issues in times of circular economy (2008-2017). Rather than having a straightforward evolution, we will show that waste-to-energy has shown an ontological shift, from a recovery logic to the designation of waste as an energy source.

Recoreving energy from waste:
New perspectives from old ideas

The willingness to make waste a resource was part of the early evolution of waste collection services and disposal techniques. At the end of the 19th century, municipalities and industries, which first engaged in waste treatment for hygienic considerations, tried to avoid or postpone disposal through efforts intended to benefit from discarded items and materials

(Barles 2005). Primarily, industrial incineration techniques were configured as recovery systems, producing electricity and steam[2] (Brunner and Rechberger 2015). But soon, incineration (without energy recovery) and landfill dominated, as did the *sinks* that cities were in search of (Tarr 1984). These disposal modes, relying on *end-of-pipe* infrastructures (Melosi 2008), carried on being developed throughout the 20th century to absorb increasing volumes of refuse. Even though evolving in terms of volume and nature, the aim was to dispose of waste, resulting from unquestioned production and consumption patterns, at great cost. These early infrastructural choices deeply established a linear approach to dealing with waste, long before it was identified as an environmental matter requiring designated public policies.

In the 1970s, waste policies were set in most Western countries. At that time, the oil crisis was generating disquiet, with threats of shortages and rising prices. It was concern over the energy supply that favoured a link between waste and energy. The early 20th century "resource concern" came back into focus after the environmental shifts during the 1970s and the adoption of the dedicated waste management policies that followed the first European Waste Directive in 1975. Primary legislation on waste adopted in both Europe and France, in 1975, mentioned energy recovery and material recycling as (equal) waste treatment modes to be fostered. However, since this legislation was not linked with any mandatory or quantified objectives, it had no tangible effect (Bertolini 1992), with waste production increasing dramatically and requiring more and more disposal facilities.

Both the oil crisis and subsequent energy stresses favoured energy recovery from waste, mainly implemented by means of incineration, recovery which gained new momentum in the 1980s and 1990s as landfilling met opposition, disincentive taxation and legal restrictions. The early 1990s were a turning point in France and Europe, when recovery and recycling gained effective support prior to elimination. The landfill ban (enacted into law in 1992 in France, and through the 1999 EU Landfill Directive) gave fresh impetus to waste policies, enacting the replacement of a then dominant *disposal mode* with a *diversion mode*, which 'served to provide a new underlying objective for waste management (the diversion of waste from landfill), to solidify a new governmental rationality based on the notion of sustainability, and to provide new governing

[2] Brunner and Rechberger (2015, 6) indicate that: 'Utilization of energy became a technical requirement when sophisticated air pollution control was introduced: the flue gas had to be cooled, and this was best done by applying first a condensation cooler, and later a heat exchanger'.

technologies' (Bulkeley, Watson and Hudson 2007, 2742). Diversion away from landfill was implemented in France by means of legal and fiscal incentives, consisting of restricting landfill access to purely non-valuable waste and of increasing taxes. These new regulatory choices acted as a boost for incineration–and, consequently, for incineration with energy recovery–resulting in the opening of new "energy recovery units" during the 1990s. If it is the case that energy-from-waste undoubtedly originated from this changing approach to waste management, aimed at diverting waste away from landfill, its success–as well as the debates it raised–has to be contextualised beyond the waste sector.

In the early 1990s, growing climate concerns started being incorporated into the waste agenda, generating an unprecedented boost for energy recovery from waste (Rocher 2009). The current energy shaping of waste originates from the climate-energy policies of the early 1990s. Climate and waste agendas have gradually been converging since then through the promotion of energy recovery from waste, and more broadly through a climate rationale incorporated into assessments and decision-making relating to waste policymaking and management. This was not without tension or contradiction when issues appeared to be competing, e.g. between energy recovery and material recycling. The 2008 EU Waste Framework Directive ranks energy recovery along the waste hierarchy as a response to the fear that energy recovery would compete with material recycling efforts and cause intensifying controversies over incineration. Although this clarified the situation by ranking energy recovery amongst other recovery and disposal modes, it did not end the debate once and for all. In January 2017, the European Commission published a communication aimed at (re)placing energy recovery along the hierarchy by means of a refined definition of energy recovery, taking into account the variety of recovery processes and making these compatible with the circular economy, which now stands as a dominant narrative regarding waste matters. Indeed, the last ten years have been marked by the proliferation of energy-from-waste operations (including waste-derived biogas), by the strengthened promotion of renewable energy, and by the intensification of the principle of the circular economy. In France, according to legislation from 2015, landfilling and incineration without energy recovery must halve by 2025.

Beyond competing issues, the very boundaries of waste at stake

Whilst well covered by management studies, in its technical and economic aspects, waste-to-energy remains underexplored in the social sciences. Logically, incineration has received a lot of attention, which has led either to concluding its conformity with a sustainable waste management (Brunner and Rechberger 2015) or to pointing to the profound contradictions it carries, notably by reason of its infrastructural obduracy (Corvellec, Zapata Campos and Zapata 2013). In the case of Gothenburg, Sweden, Corvellec et al. demonstrated how waste management happened to be locked into energy provision, with a great reliance on waste for fuelling district heating being confronted by a decrease in domestic waste generation (Corvellec, Zapata Campos and Zapata 2013). Energy recovery is generally accompanied by controversy, as incineration has proven to be a highly-challenged mode of waste treatment. Waste incineration, while allowing the local use of energy, faces poor social acceptance vis-à-vis plants (Rocher 2009, Bobbio, Melé and Ugalde 2016, Lougheed, Metuzalas and Hird 2017). While conflicts surrounding waste matters are often too rapidly equated with Nimbyism due to a lack of information, geographers and sociologists are calling for serious consideration of the role of the public in waste management (Davies 2003), drawing attention to the environmental justice issue it is linked to (Walker 2012) or outlining the political implications of making waste issuespublic or not (Hird, Lougheed and Kerry 2014). In an attempt to bring together the modes 'through which [waste] policy is constructed and contested' (Bulkeley et al. 2005, 2), our ambition here is to show how challenging incineration has impacted upon energy recovery framing. The way in which claims, advocacies, and techniques are displaced relative to one another is testament to the controversies that energy recovery causes or responds to.

Besides controversy, waste management is also characterised by powerful mottos – e.g. "wasting less" - and principles such as "hierarchy" or "circular economy", requiring a careful 'narrative watch' in terms of waste matters (Corvellec and Hultman 2012, 308). As regards energy-from-waste, this involves identifying the specific ideas or approaches pertaining to an "energy narrative" of waste, and how these impact broader policy orientations and trends. In other words, by what means is energy recovery made compatible with the principles of hierarchy and circular economy, and vice versa? The now widespread *circular economy* motto potentially deeply renews waste theory and practice by breaking with a linear approach that has long been dominant. However, such an ambition, though rather consensual, needs to be confronted with how materials actually circulate and are put into circulation by public policies, institutional and social rules and everyday practices. Advocating the need for ‘critical engagement’ with the circular economy, ‘recited as an ideal’, Gregson et al. insist on the necessity of ‘examining not just the idea of the circular economy but also the messy world of circular econom*ies*, and examining which wastes are being recovered as resources, and where’ (Gregson et al. 2015, 219). This material and moral engagement that has been suggested by Gregson et al. functions to disentangle the specific flows constituting waste streams, notably the “downstream flows” generated by various modes of waste processing, whether they be valuable (e.g. secondary materials resulting from recycling activities, scrap metals, energy) or waste products likely to cause pollution (e.g. off gas, fly and bottom ash, leakage. We argue that energy flows generated by waste treatment (mainly by incineration, but also by other processes such as landfill or anaerobic digestion) are worth examining carefully. This is because of the prominence they are gaining, and because they are likely to displace boundaries between recovery, recycling, and elimination, as is the case with many categories framed and ranked using the notion of hierarchy.

Waste studies have recently benefited from the fruitful and theoretical attention of the social sciences, as an issue being attended to in every aspect of social life and thus going beyond a purely waste management approach, to which it has long been restricted. They have also benefited from a “material” concern, i.e. an interest in how objects or (discarded) things are embedded into the physical and economic, but also the political or geographical, dimensions of modern societies. These works have helped to relativize waste frontiers by pointing out that discarding things is a matter of *displacement*, and by no means a matter of disappearance (Hawkins 2006). Although they are encountering increasing interest, waste studies have blind spots. Waste governance studies tend to focus on household waste and to care about tackling consumer behaviour, ignoring tremendous amounts of waste generated by industry, mining, or extraction activities (Hird 2017). As Gilles argues, waste scholarship as a whole has a dominant interest on the micro and household levels (Gille 2010), but is blind when talking about the social institutions and global trends from which waste originates, and which define resource consumption. To counteract this bias, the encompassing concept of the *waste regime* ‘extends attention to the very production of waste and allows us to understand the economic, social, and cultural origins of specific wastes as well as the logic of their generation’ (Gille 2010, 8). A comprehensive understanding of waste regimes should also include “output attention”, i.e. paying careful attention to the “downstream flows” - of either matter or energy - generated by waste treatment and likely to play a crucial role in waste regimes. Waste-to-energy issues, although originating at the very beginning of urban waste regimes, have been moving to the forefront with unprecedented strength since the early 1990s. Far from being an end-of-pipe by-product, which happens to be opportunistically recovered, energy seems to be taking the lead in waste matters. By instituting waste as a resource in such an overwhelming way, energy is likely to force a new ontology of waste (Hawkins 2017).

What we are interested in is characterising and localising this *waste-to-energy regime*; that is, to identify what made waste and energy connect, when these connections occurred, as well as what kind of reframing they entailed, namely the ability of energy to reset waste policy frameworks. Although having been well-established as bounded domains for a long time, waste and energy meet on the energy recovery front, both in discourse and in practice. Hypothesising that waste management rules are increasingly being shaped by energy concerns makes the notion of converging agendas helpful. The observation of Lovell et al. of a convergence between UK energy and climate agendas renews policy change analysis by explaining this through converging rather than competing agendas (Lovell, Bulkeley and Owens 2009). Identifying both climate-energy storylines and sociotechnical dimensions, they attest that convergence exists 'because energy policy has become a key arena within which policy actors seek solutions to climate change, while the climate change policy agenda has become integral to energy policy' (Lovell, Bulkeley and Owens 2009, 91). By focusing on the policy-making level in France and in Europe, it is demonstrated here how waste has become an energy issue by highlighting the processes through which energy has acted as a strategic arena for a waste sector being redefined by climate issues to the extent that it has reorganised waste management.

The next two sections describe how waste-to-energy issues have evolved over the last three decades and how they are presently being framed, by looking at different *policy instruments* pertaining to energy generation from waste. Public policy analysts suggest that, since instruments have their own lives, they should not only be considered in terms of the effects they produce, but also in terms of their ability to define public problems (Halpern, Lascoumes and Le Galès 2014). As far as waste-to-energy is concerned, specific policy tools must be looked at in two ways: The first of these is the accountancy standards established in order to assess greenhouse gas (GHG) emissions relating to waste-treatment activities. Reflecting on the making of greenhouse gas markets, Cooper (2015) shows the key importance of "metrological systems" that are able to quantify emissions and establish unified measuring units and equivalences between different objects or matter. His claims for a “critical metrology”–that is, paying ‘direct attention to how measurement is done, why commensuration occurs, the dynamics of metrological systems, and the ways in which this affects markets as intentional projects’ (Cooper 2015, 12)–resonates with our attempt to weight the role that GHG commensuration has played in framing waste as a climate–and extensively as an energy–issue. Other kinds of instruments include those aimed at directing (waste) flows by means of financial incentives and regulatory tools. Besides legal and technical provisions favouring energy recovery from waste treatment units, it is energy-centric market devices that overwhelmingly tend to design waste policy. Emerging categories, e.g. Solid Fuel Recovery (SFR), are of particular interest because, not only do they have to be fitted with the dominant principles of waste management, they also tackle the very boundaries of the waste entity.

The energy shaping of waste (1992-2008)

Formally launched in 1992, with the United Nations Framework Convention on Climate Change (UNFCCC), the objective of cutting GHG emissions has led to mitigation policies to be implemented at the national level. GHG inventories had to be carried out in several designated sectors, including waste management, highlighted as a sector not only responsible for emitting a substantial amount of GHGs, but also capable of decarbonising energy. In doing so, climate issues rapidly “colonise” the waste agenda at the European, national and local levels and it is precisely because of energy that waste and climate have converged. This convergence was driven by a combination of policy instruments, mainly directed at incineration. Though not unchallenged, waste was seen as a renewable energy and energy recovery took its place within the hierarchy framework.

Waste as a renewable energy: metrological standards and associated struggles

From the early 1990s and onwards, climate change concerns and their associated targets for cutting GHG emissions entailed a re-examination of waste treatment options. Accounting exercises required by GHG reporting, in addition to climate action plans that were being set at many levels, designated waste treatment as a substantial contributor to climate change due to its emissions of carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O). One of the first challenges was to agree on shared methods of how to estimate waste sector contributions. The IPCC played a crucial role in the setting of calculating conventions, published in its *Guidelines for GHG Inventories* (IPCC, 1995, IPCC, 2006)the IPCC . These IPCC calculating conventions established metrological methodologies (Cooper 2015) for waste-related GHG emissions, which were soon included in waste policies. In France, the Environmental Agency (ADEME) adopted the IPCC calculating convention, which resulted in the waste sector being responsible for 2% of the GHGs emitted by that country in 2007 (ADEME 2009) (Record 2008). These accountancy methods played their part in designating energy-from-waste as an alternative to fossil fuels. Indeed, on the proviso that energy was being recovered (as electricity, heat, or combined-heat-and-power), emissions from waste incineration had to be reported in the energy sector. The IPCC guidelines also introduced a distinction between *biogenic* and *fossil* CO2 emissions from incinerated waste in order to differentiate the emissions from the combustion of biomass materials (e.g. paper, food, wood waste) from those of fossil origin.

This allowed the energy recovery process, assumed to be a substitute for fossil fuels, to be recognised as a way of decarbonising the waste sector. Waste could stand as an alternative source of energy and was promoted as such by incineration companies. Energy from incineration was also championed as a solution for cutting landfill methane emissions. With their call for “energising waste”,[3] Europe-wide incineration organisations, e.g. the Confederation of European Waste-to-Energy Plants (CEWEP), participated in the development of an *energy narrative of waste*. However, estimating GHG emissions from waste is far from being an evidence-based exercise, with struggles intensifying throughout the 1990s and 2000s as a result. Numerous expert analyses and statements released by incineration promoters and challengers reflect these struggles and testify to the precarious convergence of waste and climate-energy agendas. For instance, GHG calculating methods disseminated by the CEWEP (2008) appear to be rather extensive.[4] On the other hand, Friends

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[3] Energising waste: a win-win situation [http://www.cewep.eu/wp-content/uploads/2017/09/Energy-win-win-paper-June-2017.pdf]

[4] “1. The direct emissions of CO2 calculated on the basis of the amount of fossil carbon in the waste; 2. Credits due to the production of energy replacing generation of this energy by other fuels; 3. Credits due to the recuperation and

of the Earth insist that incineration generates underestimated amounts of fossil-fuel-derived GHGs and that other treatment options (recycling or anaerobic digestion) provide better options in terms of climate change, representing an interesting alternative to energy from waste (Friends of the Earth 2006).

While energy recovery was being framed on the "waste side", an unresolved question, *Should energy from waste be considered and supported as a renewable energy*?, was being answered on the "energy side" by means of accounting standards. As energy efficiency objectives and the promotion of renewable energy were strengthening on both the European and national levels, accounting conventions were needed in order to provide energy-from-waste with status and to incorporate it into the energy policymaking process. Faced with difficulty in recognising waste as a source of renewable energy, on the same level as solar or wind power, the 2009 EU Directive on Energy from Renewable Sources recognised only the biodegradable portion of industrial and municipal waste - estimated to represent 50% of the total waste - as a renewable energy source. This accountancy framing is important in terms of energy statistics (although the most commonly used category is "renewable and recovery energy", and more significantly in terms of applying incentives and taxes. For example, in France, this ratio is applied when calculating reduced VAT and subsidies on the "renewable" part of district heating fuelled by energy from waste.

Placing energy recovery along the waste hierarchy

Through climate policies, energy recovery has gained unprecedented impetus, although not without being challenged. If incineration benefited from renewed legitimacy, the notable challenge it faced in the 1990s did not fade away in the 2000s. Pollution scandals involving dioxins and furans, due to a lack of control, arose in France and elsewhere in Europe (Bourg, Buclet and Gilotte 2003), leading to opposition movements getting particularly angry about the opening of new plants. Environmental and sanitary issues were not the only motive for a challenge that soon turned into a global approach to waste, linking disposal possibilities with the generation of waste and recycling. The over-dimensioning of plants was highlighted as the main failure and incineration was denounced for undermining both material recycling efforts (set from the mid-1990s at the

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recycling of metals from ashes replacing the production of metals from primary raw materials" (CEWEP/FFacts, 2008).

European level) and "wasting less" objectives (which became the main narrative from the early 2000s). Thus, as climate and energy concerns offered incineration new legitimacy, controversies hardened, whereby energy recovery was blamed by NGOs, which claimed hierarchized waste management, for competing with (material) recycling.

The *waste hierarchy* was introduced in the 2008 EU Waste Framework Directive as a response to the controversial debates about competing modes of waste. According to that hierarchy, waste prevention should be given priority, followed by product reuse, material recycling, energy recovery, and then landfilling as the last resort. While not legally binding, this framework was meant to align the policies of the member states that had developed their own waste hierarchies (Buclet and Godard 2001). In addition to prioritising a 'wasting less narrative' over a 'less landfilling narrative' in 'the most ecumenical way', the hierarchy model 'also ranks various ways of retrieving value from waste' (Corvellec and Hultman 2012, 302). Prioritisation of material recycling over energy recovery, long claimed by NGOs, was settled as a major principle and accompanied by technical specifications relating to energy performance levels. The "R1 Energy Efficiency formula", based on energy efficiency standards that had been introduced in 2001 in Europe and in 2002 in France,[5] formalised a recovery ratio of 0.6 (for existing plants) and 0.65 (for plants created after 2008) in order for these plants to be called 'energy recovering'. Nonetheless, the incineration processes were criticised by NGOs for their low-energy performance, notably when electricity alone is generated without heat recovery.[6] The incineration industry was also criticised for negotiating lower energy performance standards under the pretext of 'local climatic conditions', a criterion mentioned by the 2008 Directive[7] and whose definition is still under debate. As it became more sophisticated, regulation of energy recovery was incorporated into fiscal instruments: From 2009 and on, the French waste treatment tax was applied to

[5] Ministry of Environment and Sustainable Development, 2002, September 20. Order concerning non-hazardous waste incineration units.

[6] 'Government must dispel the myth that incinerators which only generate electricity produce green energy–they don't' (Friends of the Earth 2006, 7).

[7] 'Local climatic conditions may be taken into account, such as the severity of the cold and the need for heating insofar as they influence the amounts of energy that can technically be used or produced in the form of electricity, heating, cooling or processing steam' (Directive 2008/98/EC on waste).

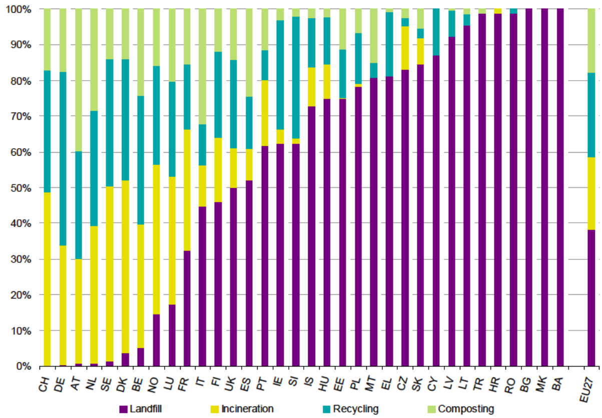

Figure 1. Municipal waste treatment in 2009 broken down by country and treatment category, and sorted by percentage of landfill (Eurostat 2001).

energy performance, amongst other environmental criteria. Although the debate about incineration conflicting with recycling efforts did not fade away, it was given a statistical response, widely disseminated by institutions and the waste industry. Indeed, the comparison of recycling/incineration and landfill rates, at the national level, shows that the countries relying most on incineration were also those with the highest material recycling scores. According to Eurostat, France ranks number 7 in Europe as regards its incineration rate (around 30%), which equates to landfilling (30%), while beating recycling (15%) and composting (15%) (see Fig.1).

Blurred frontiers: Waste as energy (2008-2017)

The 2008 framework directive, though it undoubtedly represents an important step forward in ranking energy recovery amongst treatment options, did not, however, end the debate on the waste hierarchy. Some significant changes and ongoing discussions relating to waste-to-energy regulation, on several fronts, reveal an energy shaping of waste that is intensifying. Current discussions concerning electricity-from-waste public tools, on the one hand, and creating *solid recovery fuels* (SFR) as an in-between category, on the other, are illustrations both of energy-centric concerns and instruments that are taking the lead in waste policies and of their ability to redefine what waste is.

Waste treatment driven by (multiple) energy output rationales

Waste treatment techniques most commonly allow the valuation of heat, of gas, and/or generating power, but these potential solutions are unevenly being encouraged by public policies. Besides local, technical and spatial constraints (e.g. the ability to connect to district heating or gas grids), legal regulations, prices, and financial support prove decisive when making a choice between one way or another of recovering energy. Yet, some recent changes indicate that energy output from waste is multiplying (technically and legally), while valuation conditions are proving to be rather unstable, notably with regard to electricity. Heat recovery and power generation, or both (i.e. combined heat and power), are the main modes of energy recovery from waste incineration[8]. Choozing one or the other of these solutions depends on local factors (the existence and proximity of a district heating network), but also on the economic rationale used, which is highly dependent on incentives. Power generation (though criticised for its low-energy performance) has until recently been supported by guaranteed feed-in tariffs, whereby electricity companies are obliged to buy electricity-from-waste at a fixed price for 15 years. Heat recovery has also benefited from financial support, by means of subsidies directed at ensuring that district heating uses at least 50% of renewable and recovered heat. As a result, combined heat and power, seen as the most efficient and preferred solution due to its seasonal flexibility, increased a lot in the last 15 years. But new rules might reverse this situation. Indeed, guaranteed electricity feed-in tariffs are being replaced by market rules which, although designed to be accompanied by a compensatory device, offer less economic security and rely on much more complicated processes (entailing new actors such as aggregators) than previously (AMORCE 2017). This could result in a preference for heat use over electricity.

Similar changing valuation conditions have occurred on the gas side, in the context of extended valuation possibilities regarding waste-derived biogas. In France, power generation was the only recovery possibility until 2011. However, as a result of the obligation to capture landfill methane emissions, and for the development of anaerobic digestion units, biogas–which increased in production–was allowed to be injected into the gas

[8] However, new techniques such as the gasification of pyrolysis are being developed and implemented.

grid. For all these treatment modes, what remains at stake is the making of public policies that favour the most efficient forms of recovery (heat and gas injection) without hampering others (electricity) which could appear consistent, particularly when there is no local network. The compensatory device being proposed by the French government, i.e. to replace electricity feed-in tariffs, is meeting opposition from the European Commission. Supporting the production of electricity from unsorted waste (this applies to incineration and landfill) could promote waste treatment methods that are not encouraged elsewhere. However, if public financial support were only applicable to the renewable part of waste, then electricity generation would not be economically viable. These examples signal that, parallel to a broadening of the recovery options, the financial tools that accompany these are creating competition between energy outputs. Hesitation regarding the making of these policies, mirror the dilemmas surrounding the recognition of waste as a renewable energy, and the close state of interdependence between energy flows as outputs and material flows as inputs. Ultimately, this suggests that the more waste processing choices rely on factors pertaining to energy outputs, the more energy will take the lead in waste management.

When wastes become fuel

One other significant example of the energy framing of waste is the debate concerning SFRs, designating a new category of waste intended for use as a fuel for energy plants. SFRs are made of refuse material from the sorting and recycling of non-hazardous waste which, depending on its components, may have a high calorific value. This norm allows these materials to be used at incineration plants, in co-incineration (e.g. cement kilns), and at energy plants, depending on their calorific value and environmental criteria (mercury concentration, chlorine content)[9]. Beyond the European framework, the making of public policies aimed at developing SFR industries is the business of national governments, including the option to grant them end-of-waste status (or not). The waste industry has lobbied for the development of the SFR sector and named it

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9 "According to CEN/TC 343, solid recovered fuels are defined as "solid fuel prepared from non-hazardous waste to be utilised for energy recovery in incineration and co-incineration plants" meeting the classification and specified requirements outlined in the technical specification CEN/TS 15,359". (ADEME 2012)

"the missing link of circular economy",[10] while NGOs were reluctant to the creation of this status (Zéro Déchets 2017). In France, the SFR sector is considered to have a greatly underexploited potential (mainly from industrial and commercial waste) (ADEME 2012). Yet, it is in need of structuring in order to prevent these materials from being sent abroad. A 2016 ordinance recognised and framed this use of waste by introducing a new SFR-based energy plant classification.[11] These plants can only be operated if they meet the high energy-efficiency standards (based on the calorific value of incoming materials) associated with local energy needs.

However, the French SFR framework is far from becoming stabilised. First, it faces the difficulty of designing public support tools aimed at electricity generation (mentioned above). Moreover, whilst maintaining SFR's waste status is rather consensual, there are struggles between waste actors regarding the categorisation of SFR (whether or not this should be based solely on refuse from recycling or include non-sorted domestic waste). Although seeming very specific and technical, these expert struggles actually indicate the multiple and intricate channels that energy recovery is entangled with, from the very upstream flows of waste being targeted by reduction and recycling objectives, to the competing energy outputs linked to energy regulations and markets. Whereas in classical incineration, energy is a by-product of a disposal technique, the priorities have been reversed at SFR plants: It is energy outputs that determine the quantities and qualities of the waste to be allowed as fuel.

Re-ranking waste-to-energies along the hierarchy

This expanding and competing use of waste as energy is echoed in the January 2017 European communication entitled 'The role of waste-to-energy in the circular economy'. This communication is an attempt to make the recovery of energy from waste meet the 2015 EU circular economic action plan, as well as EU legislation on waste, the Energy Union Strategy, and the Paris Agreement, and to ensure that it is 'firmly guided by the EU waste hierarchy'. It is a testament to the realignment of waste along the circular economy narrative, by tackling the contradictions inherent in waste-to-energy, while ignoring the contradiction between 'offering a transformative agenda with significant new jobs and growth

[10] See, for example, ERFO (the European association for recovered fuel from solid non-hazardous waste) [https://www.erfo.info].

[11] Ministry of Environment and Sustainable Development 2016 May 16th. Ordinance amending the classification of facilities listed for environmental protection.

potential' (European Commission 2017, 2) and waste minimisation that was noted by, for instance, Desvaux (2017). Various waste-treatment processes that generate energy are positioned along the waste hierarchy, with a view to directing the funding and planning of public financial support. This official release is of significant interest, as it signals the need to adapt the hierarchy framework to a new, albeit unstable, waste-to-energy reality that consists of a variety of processes and a complexity of issues. Beyond dedicated incineration, a distinction is made between the different energy flows in order to rank them as being equal not only to "recovery", but also to recycling or disposal (see Fig. 2). Thus, biogas from the anaerobic digestion of organic waste, on the proviso that the digestate is recycled as a fertiliser, is regarded to be a recycling operation. On the other hand, biogas from landfill is classified as disposal. Incineration and co-incineration are ranked as "other recovery" or disposal, depending on their recovery performance. As for SFR, the 'reprocessing of waste into material that is to be used as solid, liquid or gaseous fuels' is considered to be a form of recovery.

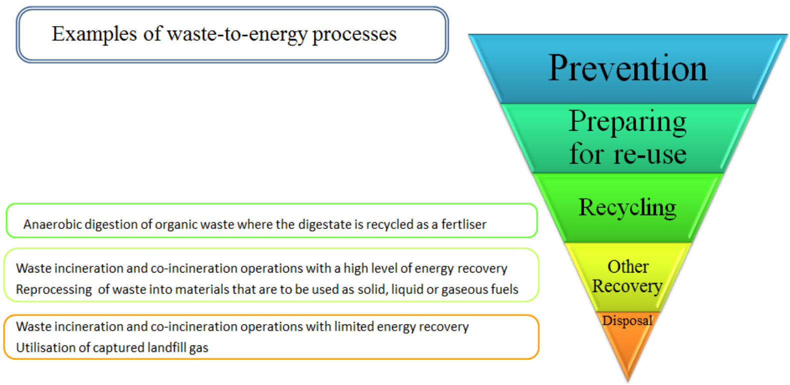

Figure 2. The waste hierarchy and waste-to-energy processes (European Commission 2017, 4).

Discussion. From energy recovery to waste as energy: Lessons from a diachronic analysis

Analysis has shown two distinct periods, as far as energy recovery from waste is concerned. During the first period (1992-2008), the converging agendas of climate and waste resulted in an unprecedented boost for energy recovery. This consisted of framing and locating energy as a key issue in waste management using a set of policy instruments, amongst which accountancy tools played a crucial role. A *metrological system* (Cooper 2015) of waste relating to GHGs rapidly invaded the waste sector on many levels, from international to local. These calculation standards were important vectors in the energy shaping of waste. Not only are they the channels via which climate and energy concerns have colonised the waste sector, which was asked to account for its GHG emissions and energy consumption and production, they also work closely with incentive and regulatory tools focusing on energy recovery (tax, energy performance standards and favouring "renewable energy". Waste and climate policies *converged* on the basis of energy (Lovell et al. 2009), although not consensually. Energy recovery became the main reason why incineration gained legitimacy, while simultaneously being challenged by intensified claims and lobbying on the part of both NGOs and industry. Over that period, controversies surrounding incineration changed and multiplied on many fronts. Primarily centred on its environmental and sanitary impact, incineration was challenged on the basis that it contradicted objectives of "wasting less" and recycling. These debates somehow succeeded in reorientating waste policy when the principle of a hierarchy was introduced in the 2008 EU directive. This consisted of ranking waste-to-energy as a less preferable option than material recycling, but still better than disposal.

The last ten years (2008-2017) represent a second period during which we assume that energy has become a predominant driver of waste policies. The refinement of rules and tools, allowing diversified practices of energy recovery, suggests that energy outputs not only appear as byproducts worthy of recovery, but also as ends in themselves that tend to dominate waste policymaking on various levels, and are likely to determine local waste management choices. While different forms of energy recovery from waste are potentially in competition, they are regulated by energy-centric rules (e.g. electricity feed-in tariffs), indicating that energy rationales are taking the lead in waste management. The SFR status, which formats waste as a fuel, is symptomatic of the ability of energy to displace the very boundaries of waste, and to redefine what waste is and what it is not. The 2017 EU communication, consisting of a re-ranking of energy recovery processes along the hierarchy principle and adjusting it to that of the circular economy, signals a realignment of waste principles in respect of energy outputs.

By following a waste-to-energy appraisal over time, this diachronic analysis has shown a gradual change, driven by means of specific and technical tools, occurring in a rather discrete mode, even if incineration has sparked contradictory debates. Between the two periods of time identified, this change is nonetheless profound, as a waste-to-energy rationale that has shifted to energy-from-waste, in other words, of waste *as* energy. First conceived of as a recovery concern, i.e. making opportunistic use of a wasted resource, recent developments in waste-to-energy are gaining the ability to redefine waste as a source of energy, in fortunate agreement with the circular economy motto. This calls for including a thorough attention to energy outputs in the efforts made to characterise *waste regimes* (Gille 2010). Making waste into energy carries, amongst other things, *ontological displacements* (Hawkings 2017) that should be further scrutinised by means of paying careful attention to the material and moral circuits (Gregson et al. 2015). In this regard, critically engaging in examining the 'messy world of circular econom*ies'* (Gregson et al. 2015, 219), as well as a 'narrative watch' (Corvellec and Hultman 2012, 308), will be needed more than ever. Finally, energy recovery appears to be embroiled in a tough debate, reminding us to pay careful attention to controversy in waste matters. This allows us to understand, over and above refusing to build new plants, how such debates, whatever their conflicting degree and scope, play a decisive role in agenda-setting and policymaking.

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