Incineration: what's the effect on gas consumption?

Executive summary

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Context

The war in Ukraine has led to major shifts in the EU's energy markets. A combination of Russia's weaponising of its energy supplies by reducing supply, particularly of gas, allied with a determination on the part of the majority of EU member states to stem the flow of energy-related revenue to Russia, has led to a significant increase in the price of gas in wholesale markets. Prices in EU electricity markets are generally set through marginal pricing on the basis of day-ahead supply offers and demand bids, with market equilibrium rules deriving prices for each hour of the delivery day.

30 years after the United Nations Framework Convention on Climate Change entered into force, the EU27, as a bloc, remains stubbornly reliant on fossil fuels for its energy supply. Gas has frequently been perceived as part of a transition pathway through which member states could pass on the way to a lower carbon future. The experience, back in the 1990s, of the UK's progressive shift from coal to gas, and the significant (in percentage terms) reduction in greenhouse gas emissions to which this led, has raised the prospect of a seductively simple route to the phasing out of coal, with one form of centralised fossil-based generation being replaced by a somewhat lower carbon alternative. Similarly, at the household level, shifting away from solid fossil fuels to gas-fired boilers has offered a route to a reduction in greenhouse gas emissions linked to the heating of households in those countries where solid fuels have dominated.

There is panic in the air. Addressing climate change – still seen as a relatively long-term objective, despite the growing weight of evidence that suggests the need for radical emissions reduction is urgent – is at risk of being placed, temporarily, on the fossil-fuelled back burner. Several member states are seeking to address the current turmoil in the gas, and hence, electricity market by a range of measures, ranging from demand reduction, to back-pedalling (hopefully, only temporarily) on commitments previously made to scale-back or phase out fuels that are now being regarded as an evil made necessary by the far greater evil of Russia's invasion of Ukraine.

Waste management and the energy crisis

In this context, it might be tempting for any supplier of energy that is unrelated to the use of fossil-derived oil and gas to highlight the potential merit of their offering. The waste management industry has advanced its case as a potential contributor to a solution to the gas and climate crises. And it is undoubtedly true that this may be the case. Where increased recycling can supplant EU-based production from primary materials, it can reduce demand for fossil-derived energy and/or fossil-derived feedstocks, and reduce overall demand for energy. Furthermore, recycling processes themselves may be more amenable to deployment of renewable energy sources than primary ones (mechanical recycling of plastics being a good example here). Separate collection of unavoidable food waste might enable more biogas to be generated at anaerobic digesters, with the cleaned gas allowing use for heating. These changes are, by and large, consistent with the direction of travel for the EU for the medium-term, and show some alignment with a strategy for addressing climate change. Beyond the management of waste that is being generated, prevention of waste through reduced consumption, and consumption shifting towards longer lasting products, and wider adoption of reuse/refill can reduce the use of energy which is embodied in the products that we consume.

Somewhat more controversially, the waste management industry has claimed that incineration and co-incineration could be deployed more widely than is currently the case, with claimed benefits for climate change, and fossil fuel consumption. For example, a recent FEAD Press Release noted:[1]

> *Whereas member states reached yesterday a political agreement on a voluntary reduction of natural gas demand by 15% this winter, and the European Commission has recently presented the REPowerEU Plan in response to the hardships and*

global energy market disruption caused by Russia's invasion of Ukraine, the waste management sector is not (yet) at its full capacity of producing and saving energy.

Today more than ever it is essential to end the EU's dependence on Russian fossil fuels and to tackle the climate crisis, which can be done "through energy savings, diversification of energy supplies, and accelerated roll-out of renewable energy to replace fossil fuels in homes, industry and power generation".[1] Here, the waste management sector has a fundamental role to play as:

- *recycling and recovery operations save material resources, energy and CO2 emissions by avoiding the extraction, processing and use of virgin raw materials and fossil fuels; and*
- *the electricity and heat produced from waste through incineration and anaerobic digestion is generated from a local, reliable and secure source, which allows to diversify our energy supply, in particular with regards to District Heating and Cooling networks, and accelerates the roll out of renewable energy.*

At the philosophical level, the argument that waste – of whatever origin, and however used – could be considered as 'renewable' is not, and never has been, especially credible. Waste prevention sits, rightly, at the apex of the waste management hierarchy. No industry sets out with an objective of generating waste. Wasted materials represent wasted embodied energy and emissions. As long as we have waste, it should, of course, be managed, but in the context of frameworks designed to reduce its generation. Claiming that waste should be viewed as a resource which is "renewable" is problematic. The energy derived from it may, depending on how it is derived, and how one accounts for different pools of carbon, be low in its (fossil) carbon intensity. That, though, is a distinct question to the decision regarding its "renewable" nature.[2]

Accepting terminology as it is currently applied, only the energy derived from non-fossil resources is currently considered renewable.[3] Where incineration of leftover (after source separation) mixed waste is concerned, most member states assume that around half of this is "renewable", and the rest is "non-renewable". The "non-renewable" energy is largely derived from plastics. A recent report indicates how reliant the EU plastics industry is on use of gas and oil.[4] It follows that unless the waste is of a somewhat strange origin, or unless there is a targeted attempt to remove all plastics, then incineration will not lead to generation of purely renewable energy, even under existing definitions. Any "low-carbon" energy which is generated is delivered simultaneously alongside energy with a high fossil carbon content.[5] It follows that incinerating leftover mixed waste will not be part of a long-term solution to the issues of climate change and dependence on gas without a concerted attempt to address the "non-renewable" component that gives rise to fossil-derived carbon emissions (or until facilities are equipped with carbon capture, utilisation and or storage).

How much gas does incineration displace?

Electricity and heat are already being produced by incineration. Existing facilities make no additional contribution to reducing gas consumption unless they generate more energy. The level of gas consumption already takes existing generation into account. We sought to understand – using 2020 data – the impact of incineration on gas consumption under different assumptions.

Unrealistic maximum

The claimed potential for energy from incineration and co-incineration to displace energy derived from fossil fuels imported from Russia mainly concerns gas. Incineration is used to generate electricity and/or heat, and it is gas, as opposed to oil, that plays the more important role in the supply of electricity and heat.[6] The EU is heavily dependent on imports for its gas. EU production of gas is more or less the same as the EU's exports, so that imports equate, more or less, to the quantity of gas available for final consumption in the EU.

Using data from Eurostat, we estimated the amount of gas that might be displaced by incineration under the unrealistic assumption that all electricity and all derived heat produced in 2020 was displacing energy from gas. This considers all incinerated waste, whether renewable or non-renewable in origin, and whether municipal or not. The total amount of gas displaced by electricity production would equate to around 1.9% of total current demand for gas. Derived heat produced from waste equates to a further 1.8%.

Average EU27 mix assumption

The assumption, though, that energy derived from incineration always displaces gas is clearly not always true. Recent work for FEAD, CEWEP, the Dutch Waste Management Association and the RDF Industry Group, conducted by Prognos and CE Delft, assessed the impact of changes in waste management on climate change. In the central assumption, the avoided source of electricity and heat was the average mix of fuels used to generate electricity or heat.[7] If this assumption was applied to 2020 levels of generation of electricity and heat from waste, then electricity would displace around 0.4% of gas imports, and heat would displace around 0.7% of gas imports.

Average Mix, member state-specific

The same analysis was conducted using Member State-specific figures for the average mix of sources of electricity and heat. The overall contribution was very similar to the average EU27 mix, although more of the gas displacement was associated with electricity, and less with heat, under this assumption. The contribution to avoided gas use comes predominantly through the power and derived heat generation in a small number of countries. Incineration capacity in the EU is unevenly distributed across member states, but this analysis indicates that the gas displacement is not directly linked to the quantity of energy generated, or waste incinerated. A small number of member states feature disproportionately relative to waste incinerated.

Marginal Mix, member state-specific

These results indicate a smaller displacement of gas from electricity generation of 0.29% and from heat generation, of 0.42%. Under this approach, a similar group of member states (as are indicated by the 'Member State average mix' analysis) are responsible for the majority of the gas displaced.

Summary results

The results under the four Scenarios, and comments regarding their application, are shown in Table 1. It might be reasonable to assume a displacement of the order of 1.1% of current gas consumption linked to existing incineration. The scope for additional incineration is, however, limited, and we suggest that a more thoughtful application of the marginal mix approach should be used to understand the impact of any new incinerators being used to supply energy and heat in future (and similarly, in relation to decisions to phase out existing incineration capacity).

Table 1: Avoided Gas Consumption from Incineration Under Different Assumptions, and Applicability of Approaches

	Electricity	Heat	Comments re: applicability
Unrealistic Maximum Assumption – always Gas	1.9%	1.8%	Never applicable – sets an upper bound to contextualise analysis
Simple Assumption – EU Average Mix	0.39%	0.73%	Only for 'quick and dirty' analysis of scale of impact of existing facilities – assumes averages irrespective of country-specific

	Electricity	Heat	Comments re: applicability
			conditions
Simple Assumption – MS Specific Average Mix	0.45%	0.65%	Allows some Member State-specific insight into effect of existing facilities. Can only give a snapshot of reality (no appreciation of dynamics) so cannot be applied over a facility's lifetime Drawbacks are its lack of distinction between 'firm' sources of energy heat, and sources whose role is magnified in times of peak demand.
Marginal Capacity Assumption	0.29%	0.42%	Allows some Member State-specific insight – more appropriate for new facilities Drawbacks are lack of distinction between 'firm' sources of energy / heat, and sources whose role is magnified in times of peak demand. Also, it is backward looking and sensitive to the chosen time-period. Takes insufficient account of recently announced / implemented firm policies

Appropriate counterfactuals

If incineration/co-incineration is to contribute additional energy above and beyond what it currently generates, this could happen in a number of ways:

1. Capacity Utilisation

Where dedicated facilities are not currently operating at capacity, there could be additional waste combusted. In the system context, understanding what might otherwise have happened to that waste may be important – even where the same waste would have been landfilled, landfilling may have led to energy being generated through gas collection. If the waste might otherwise have been recycled, then the issue of the implications of 'not recycling', and where that recycling might have taken place, might be considered relevant.

The consequences of the change for the energy system would also need to be considered, and this depends on a range of issues related to the nature of the facility, the nature of the energy generated, the nature of the users, the sources currently used to supply energy in the forms generated, and the policies being pursued in the member state (and region) concerned, both in respect of waste and energy.

Regarding this option, the extent of existing spare capacity is unclear. The R1 (recovery) criterion has facilitated greater movement of waste for incineration (and co-incineration) across the EU. In principle, that should enable greater capacity utilisation across the EU. If rising energy prices are reflected in the price at which energy is sold by the operator of the incinerator, then the net (marginal) costs of incineration may be expected to fall. This alone might be expected to lead to uptake of additional capacity. Note, in this regard, that the rationale for member states altering tax plans vis a vis incineration may be at risk of overlooking this point. The cost of the inputs to existing incineration in plants, in terms of auxiliary materials, may be increasing in line with rising prices across the economy, but revenues from the sale of energy may well be on the increase also, so that net costs might not necessarily be rising;

2. Co-incineration

In the case of co-incineration, there could be additional waste used as a source of energy in such facilities. The use of waste in co-incineration facilities may be constrained by the extent to which the facility (e.g., a cement kiln) is equipped to handle waste materials, the extent to which the waste is prepared in a form suitable for use (facilities may be equipped differently to handle waste with higher chlorine content, for example), as well as (in some cases) the applicable permits, which might limit the extent of use of different sources of energy. Cement kilns and power generation facilities may already be expected to have incentives, notably through the emissions trading scheme (ETS), but also, price volatility of fossil fuels, to substitute the use of fossil fuels with alternative sources of energy, especially (though not only) those which have a high non-fossil content. Different wastes may be more or less attractive at these times.

A recent paper from Cembureau highlights, also, that the cement industry is a marginal user of gas as a source of fuel.[8] The paper indicates that so called alternative fuels, those based on waste materials and biomass, now account for around half the fuel input for cement production. Of the remaining 50% of fuel use based on fossil fuels, the main ones are petcoke, along with coal and lignite. Natural gas, along with diesel oil and shale, account for 2% of the fossil fuel use, or 1% of total energy use.

The extent to which further substitution by alternative fuels is possible will, most likely, depend upon a range of factors, but it is expected that many producers will already be operating close to maximum rates of fuel substitution, subject to the constraints of their facilities. Some facilities could, in principle, bring forward investments to enable greater use of waste as an alternative fuel.

The major issue affecting cement producers today – according to Cembureau - might be the cost not of the fuel mix, but of electricity needed to operate facilities.[9]

Lastly, as the cement industry seeks to meet its own targets for further substitution by alternative fuels, it will seek to shift the use of these from the 2019 level of 50%, of which 18% was biomass, to 60% by 2030, of which 30% should be biomass, and 90% alternative fuels by 2050, with 50% biomass. There is, therefore, limited scope for using more non-biomass alternative fuels in the mix by 2030 if these targets are to be achieved, let alone if the 2050 targets are to be met. These targets are linked to the sector's net zero strategy. Indeed, a consequential analysis might suggest that if these targets are being taken seriously, then increased use of waste might be displacing more biomass-rich alternative fuels.

Note also that although there is very limited use of gas at present, that in itself would not be a sufficient reason to argue that gas was not being displaced when additional waste is coincinerated. Suppose, for example, that a key shift in the sector was a move away from petcoke and coal/lignite and towards gas, but that this had barely begun. In those circumstances, it might be possible to argue that gas was the displaced source of fuel. This highlights one reason why 'average mix', or attributional approaches are likely to offer the wrong results.

Similar comments could be made in relation to the power sector. The case for further use of leftover mixed wastes in electricity production seems, for anything other than a short-term means of ameliorating a tight market, likely to be limited by the design of facilities, and the extent to which they are geared up to receive such wastes. Those which are able to use prepared forms of waste, such as solid recovered fuel, might be better equipped to utilise waste in a prepared form, but their ability to increase co-incineration may be limited by the extent to which wastes have been prepared in such a way as to allow them to process the wastes without detrimentally impacting on their wider operation.

3. New Incineration Capacity

The final option is to develop new capacity for incineration. Unless plans are already being made in this regard, then it seems unlikely that a facility could be constructed and commissioned in the short-term. In a recent FEAD/ČAObH event, the suggested time that might elapse between planning for, and completing a new facility was placed at seven years.[10] There will, clearly, be instances where such a time period can be reduced (for example, where municipalities own / finance their own infrastructure, or where plans are already far advanced), but the construction period alone is likely to extend to a period which may or not endure beyond the period of the ongoing conflict/market turmoil. If the business case for the facility's construction rests on energy prices which prevail in a period of market turmoil, then how might that case look at the time when the facility becomes operational, and over its expected lifetime?

The reality is that decisions as to whether or not to build a waste management facility are likely to continue to be driven more by considerations of how best to manage waste in the round and with the future in mind, than by the contribution which waste could make to energy markets in the short-term. Understanding the latter in the context of the former may be important in future decarbonisation pathways (for instance, in requiring sorting of leftover mixed waste, and carbon capture and storage at dedicated incinerators, and at co-incineration facilities).

If, taking those factors into account, the decision is made to construct a new incineration facility, then there is a question to be asked as to what energy source, or sources, may be being displaced by the facility, recognising that unless otherwise explicitly planned for, it is likely to be in place for a period of the order of 20 years.

This report spends some time on the question just raised: what source of energy might be considered to be avoided by a new incinerator? We noted above that lifecycle assessment methodology has attempted to distinguish two approaches, the attributional approach, and the consequential approach, with the latter being the method of choice where the analysis is oriented towards informing decision making (it is not entirely obvious why one would resort to an attributional approach other than to significantly simplify the analysis where the information or data necessary to conduct consequential analyses are unavailable).

These approaches have often been likened, or deemed equivalent to (often incorrectly) approaches to analysing avoided energy mixes either by reference to 'average mix' of generation of delivered power or heat (attributional), or 'marginal sources' of the mix of power or heat (consequential). The term 'marginal', though, can be used in all sorts of ways: for example, work undertaken for FEAD by Prognos and CE Delft took 'marginal' to mean 'the most carbon intense' sources.[11] Others have considered this in terms of marginal sources of capacity.[12] Other uses of the term 'marginal' have also been applied, notably in respect of costs. A much-discussed characteristic of EU electricity markets right now is the system of marginal cost pricing – matching of day-ahead supply with the level of demand allows the electricity price to be set by the cost of supply of the marginal (in the economic sense) source. As gas prices have risen, and because the marginal cost of electricity production from gas is influenced by the price of the fuel itself, so the role of gas in setting prices has become prominent, even more so than it already was in some member states.

We consider appropriate questions regarding the counterfactual scenario in relation to new incineration investments. We find it unlikely that, over the course of a facility's lifetime, given the decarbonisation imperative (which, notwithstanding short-term decisions in respect of existing market conditions, will remain), the displacement effect of incineration will be relative to fossil-carbon intense sources of energy. Instead, the displaced sources are likely to be the 'firm', or 'invariant' sources of electricity or heat that will come to dominate specific member states' energy supply in a net zero future. In some countries, it is already becoming clear what these firm loads are likely to be, in others, it is less so. In such a future, some member states may well still have some resort to gas a dispatchable source of electricity, not least as a form of supply that matches fluctuations in generation by variable renewables such as wind and solar.

The fundamental role of incineration is likely to remain the treatment of waste. Indeed, to the extent that it remains as a form of waste treatment, then to the extent that fossil-derived materials remain within the combusted waste, so the fossil-derived CO_2 emissions will likely become increasingly problematic. Managers of power grids will, for the time being, view the energy generated by existing waste incinerators as a useful adjunct to its principal function. In specific locations, where waste is providing a key source of heat into district heating networks, its role as a supplier of energy may be more important, but new waste incineration facilities will likely be planned mainly on the basis of strategies and plans for managing waste, not on the basis of policies on energy, unless policy was to shift in such a way as to incentivise – for the medium- to long-term – the generation of energy from waste incineration facilities. Such incentives – in the form of price support for renewable energy generation, or in the form of exemptions from taxes that might otherwise apply – affect the costs of incinerating waste, and have played a role in reducing the costs of incineration in the past. Yet the fact that incinerating waste is never entirely renewable, and that the activity also releases fossil-derived CO_2 into the atmosphere (as well as a roughly equal fraction of CO_2 of non-fossil origin), is leading to questions as to how to constrain these emissions through either taxation, or including incineration within the ETS (where it is not already included). In any event, the effect of new incineration on the wider energy system will be affected by the strength of commitments to shift generation of electricity and heat away from reliance on fossil fuels (and to ensure that, where fossil fuels continue to be used, that the majority of the CO_2 emitted is captured).[13]

There have been major developments in renewable energy supply over recent years. In the case of wind and solar, however, these offer supplies of electricity (and heat, in the case of solar thermal) which vary across any 24 hour period, and with the seasons. As a result, matching supply and demand in the case of these variable renewable energy sources has to be considered if renewables are to be integrated into the energy mix. Some fuels are designed to be more easily turned on and off (or to increase, or scale back, supply) to match demand, and these are considered dispatchable sources of supply, such as the fossil-derived gas or coal, or low-carbon sources, such as biomass and hydro. Hence, the increased penetration by renewables may be accompanied, in some member states, by some 'matching' use of locally available dispatchable sources, at least until matching is achieved better by smarter use of energy, deployment of storage, or (likely) both (and even then, such dispatchable sources are likely to have a role to play). Integrating EU electricity markets may help in the process of reducing the carbon intensity of these more rapidly than would otherwise be the case (not least in enabling more rational deployment of variable renewables across demand that spans a wider geographic territory).

Conclusions and recommendations

Understanding the effects of waste incineration on sources of energy consumption is not entirely straightforward, and claims are made in various directions: whilst it might be politically eye-catching to argue that gas is displaced today, on another day, the advocates of incineration will claim displacement of coal, a claim which, thankfully, over the last decade, has become more difficult (if not impossible) to sustain in most member states.

Marginal changes in the quantity of waste used to generate energy from an existing facility ought to be considered quite differently to decisions to invest in new capacity. In the former case, without clear sight of the counterfactual at the time a given facility was planned, then the best approach to the counterfactual for a power generating installation might be (as long as the increase is sustained over time) to consider the impact of incinerating waste on the firm supply of electricity; what other firm sources of supply are used, and what source might preferentially be reduced as a consequence of the additional generation from the incinerator? In the case of heat, and existing heat networks, then the counterfactual can be similarly construed.

For co-incineration, the considerations seem different for power and for cement kilns. The relevant consideration for a coal fired power plant is not necessarily the displacement, at the facility, of calorific value from coal by calorific value derived from waste. The facility, and the electricity network, may be under wider constraints that incentivise use of sources other than coal. An increase in waste use at a given facility might, proximately, be seen to replace the use of coal, but in the system context, it might displace other sources. Where cement kilns are concerned, depending on incentives and constraints, displacement of other alternative fuels may be a plausible counterfactual (or no less plausible that the displacement of conventional fossil fuels).

If one assumes, in the absence of better information on specifics of each facility, and recognising that this is unlikely to reflect the average mix of 'firm sources' of energy and heat, that what is displaced by existing facilities is 'the average mix' of power or derived heat, then we estimate that the contribution of incineration is to reduce EU27 gas consumption by 1.1% (or around 2.5% of the level of import of gas from Russia in 2020). This should not be considered as an additional contribution to what now happens: it is an estimate of the effect of existing incineration on EU27 gas consumption.

The case for building new facilities has to be set against the backdrop of an urgent need – with the urgency heightened by the current crisis related to Russia's invasion – to decarbonise energy and waste. As we have highlighted previously, this would

argue in favour of deployment of the sorting of mixed leftover waste before waste is incinerated, and also, in front of facilities which stabilise waste prior to landfilling.[14] Given the effect of the former on the capacity of incinerators to treat waste, the need for additional capacity is minimised, whilst it also becomes diminishingly desirable as the displaced energy source for new capacity declines in carbon intensity in the face of renewed commitments to tackle greenhouse gas emissions from energy generation. It should also be considered that the time to develop new incineration facilities is unlikely to be short where these have not already been planned. In the short-term, therefore, **it seems highly unlikely that an additional contribution from incineration will be forthcoming, whilst in the longer-term, the case for additional capacity remains weak**.

Perhaps the most important recommendation that flows from this is that, although some unpalatable decisions may need to be taken in the short-term (in that they imply a temporary relaxation of commitments to climate change goals), it makes no sense to allow short-term perturbations, however large, to derail plans to decarbonise energy. On the contrary, this shock might even provide a reality check on the pace at which change has to be made in many member states. Notwithstanding progress made in increasing renewable and low-carbon energy generation, EU energy supplies are still heavily dependent on carbon-intense supplies based on fossil fuels. Campaigns to cease use of, or investment in, coal go nowhere near far enough, and may even have tempted some policy-makers to imagine that increasing supplies from gas, as an interim step as coal is phased out, will suffice to meet climate change objectives. That is not the case.

As long as it might be possible to sustain the argument that additional generation of heat or power from whatever source always displaces a carbon intense source of energy, then it is likely that we are continuing to fail to configure policy and markets to deliver the necessary outcomes. In reality, these sources need to be marginalised to such an extent that their phase out is secured, and so that the sources displaced are not those whose demise is secured by regulation and incentives, but the other sources that would otherwise have been included as part of the mix in achieving the desired objectives.

Time is not on our side. We do not have the luxury of multiple investment cycles in which to act. In terms of the lifetimes of fossil-fuel powered assets, radical changes need to be made over a time period which is less than one investment cycle. The time for discussing 'transition technologies' has passed; adopting such pathways will likely increase costs if climate change targets are to be met by effectively 'designing in' investment in assets which are destined to become stranded (because they must). No doubt, in a suitable rapid planned transition, some assets will indeed be under-utilised, and policy-makers may need to plan for this (and minimise it through rational planning, and at EU level, further improving market integration), recognising that it is a price that may well be worth paying in playing a leadership role on climate change, and reducing dependence on sources of energy who cannot be relied to act in good faith. Rather than considering an expansion of facilities which, without CCUS, are significant emitters of CO_2, and which will neither become operational in the short-term, nor be straightforward to 'switch off', the objective should be to focus on reducing consumption (and waste), and maximising recycling of materials at end of life, including through use of mixed waste sorting prior to incineration. This last measure would actually have the effect of increasing the capacity of existing facilities to treat waste, should that be needed.

Finally, and in relation to the transition, the EU would be well advised to consider the geopolitical risks associated with the supply of products and raw materials whose use is central to those technologies that will be needed to support a transition to a net zero EU. It would be unfortunate, to put it mildly, if the EU (and other countries) become overly-reliant for the supply of key materials on a narrow supplier base of varying reliability. A balance of indigenous supply, and support for diverse sources of supply from outside the EU, will be necessary, as well as the development of a recycling industry that builds on EU expertise to ensure that the extraction of critical raw materials is maximised at end of life.

References

[1] FEAD (2022) The waste management sector is not at its full capacity of producing energy, *Press Release*, 27 July 2022, https://fead.be/position/the-waste-management-sector-is-not-at-its-full-capacity-of-producing-energy/

[2] Of course, this raises questions as to whether the term 'renewable' is at all useful: should the focus not be on the carbon intensity of the sources of energy we use? The term 'renewable' might still be useful: we should seek to derive energy, and materials, from sources which are both low in carbon intensity, and are not diminishing the stock of capital from which resources are drawn. Non-renewable sources, by definition, draw down resources which are not replaced. Even the non-fossil component of waste includes materials which can be derived from practices which could not be considered 'renewable', whether this be in the manner in which timber, for example, is harvested, or the type of ecosystem from which it is harvested.

[3] There are ongoing discussions, in the context of the Renewable Energy Directive, as to whether additional criteria should be applied at facilities such as incineration facilities where, for example, the generation of energy that is considered renewable is always accompanied by generation of non-renewable energy of fossil carbon origin (with associated implications for fossil-derived carbon dioxide emissions).

[4] See Break Free From Plastic and CIEL (2022) *Winter is Coming: Plastic has to Go*, September 2022, https://www.ciel.org/wp-content/uploads/2022/09/September-2022-CIEL-BFFP-Winter-is-coming-report.pdf .

[5] See, for example, D. Hogg (2022) *The case for sorting recyclables prior to landfill and incineration*, Report for Reloop, June 2022; D. Hogg (2021) *Rethinking the EU Landfill Target*, Equanimator Report for Zero Waste Europe, October 2021.

[6] Note, though, that both oil and gas are used in plastics production in the EU27. As an energy carrier in the EU, oil is more closely linked to use in transport, though this is far from exclusively the case. Around 1.8% of gross electricity production, and an amount of heat production equivalent to 3% of gross derived heat production is derived from oil and petroleum products. By comparison, gas accounts for around 20% of gross electricity supply, and is responsible for heating equivalent to almost 5 times the gross generation of derived heat (most of the heat generated from gas is not via central facilities).

[7] Prognos and CE Delft (2022) *CO_2 Reduction Potential in European Waste Management*, Study for FEAD, CEWEP, Dutch Waste Management Association and RDF Industry Group, January 2022.

[8] Cembureau (2022) *The War in Ukraine, Repower EU and the EU Cement Industry – Taking Decisive Policy Actions in a Changing Geopolitical Context*, April 2022.

[9] See Cembureau (2022) *Energy Prices – CEMBUREAU statement*, 5th September 2022, https://cembureau.eu/media/peapvljn/220905-cembureau-statement-energy-prices-september-2022.pdf

[10] https://caobh-eventy.cz/konference_fead.html

[11] Prognos and CE Delft (2022) *CO_2 Reduction Potential in European Waste Management*, Study for FEAD, CEWEP, Dutch Waste Management Association and RDF Industry Group, January 2022.

[12] See, for example, I. Muñoz and B. P. Weidema (2021) *Example – Marginal Electricity in Denmark. Version: 2021-06-08.* www.consequential-lca.org

[13] In a net zero consistent pathway, as the supply from renewables whose supply is variable increases, fossil fuels may have a role to play as a matching dispatchable source of energy. To the extent that they continue to do this, they may need to be equipped with CCUS in future.

[14] D. Hogg (2022) *The case for sorting recyclables prior to landfill and incineration*, Report for Reloop, June 2022.

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Zero Waste Europe is the European network of communities, local leaders, experts, and change agents working towards the elimination of waste in our society. We advocate for sustainable systems and the redesign of our relationship with resources, to accelerate a just transition towards zero waste for the benefit of people and the planet.

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