EXECUTIVE SUMMARY

Assessing technical options for the treatment of mixed plastics as a business opportunity for Veolia ES

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Aim & objectives:
The present study had the aim to research on the technical capability of the existing mechanical recycling technologies to deal with mixed plastics (i.e. the non-bottle domestic plastic packaging waste stream) and explore the business opportunity for Veolia ES towards the investment in this developing field.

Two main objectives were identified:

- The research on the wide range of existing technologies for the mechanical recycling of mixed plastics, mainly focused on the technologies that have been practically trialled in the UK
- The conduct of an economic evaluation of a small-scale mixed plastics plant for the treatment of Veolia’s mixed plastic arising tonnage

Introduction:
The amount of mixed plastics disposed of in the UK each year has reached the 1 million tonnes and further increase is expected in the future; it now represents at least 9% of household waste by weight. Although this waste stream has a great share of the total plastic waste produced in the UK, the ways to manage it are underdeveloped with 90% of the material currently been treated as residual waste and disposed of to landfill sites.

Since the management of this complex waste stream is not a straightforward case, the UK government conducted, in 2008, a Life Cycle Assessment to compare a number of different treatment scenarios. The study concluded that the mechanical recycling is the route which yields the highest overall environmental benefit (provided that the plastic recyclates can substitute for virgin resins) and in response to the study’s results decided to give a boost to the mechanical recycling of mixed plastics by investing in research projects and providing financial support to investors in mixed plastics reprocessing capacity in the UK.

Under these circumstances, the present study will primarily explore the technical basis of the several existing mechanical recycling technologies and the business opportunity for Veolia ES of investing in this developing field. Further considerations related to the barriers and the drivers for the development of this treatment route in the UK, as well as to its eco-profile will also be discussed.

Methodology:
The realisation of the study was based on the following steps:
The first step was the consultation of the literature regarding: firstly, the several waste management options for the treatment of mixed plastics, in order to acquire ground-level knowledge on the issue and secondly, the mechanical recycling processes, especially focusing on the current projects that have been conducted by the Waste and Resources Action Programme (WRAP), to obtain an in-depth knowledge regarding the results of the mixed plastics recycling trials performed in the UK.

The next step was the economic evaluation of three potential recycling processes. The processes’ flowsheets were sourced from a report conducted by WRAP and the economic viability of a small scale treatment plant based on each one of these processes was assessed. The data required for the economic assessment were obtained by: a) personal communications with technology providers, which provided the costs for the main parts of the equipment and b) literature research, yielding generic data on which the realisation of the estimations for the capital investment and the operational costs was based.

Field visits and personal communications with experienced people in different fields (waste management & plastic recycling sector, environmental consultancy and academic research) was also an extremely valuable component of the process, which resulted in the clarification of ambiguous areas and of the point of view of important ‘links’ of the plastics supply chain.

**Results:**

The literature review demonstrated that there are several reprocessing techniques that can cope with heterogeneous polymer mixes, being at the same time tolerant to a number of contaminants; however this kind of processing is yielding coarse plastic articles that can only be used in wood/concrete replacing applications. This kind of process is called ‘downgrading’ and is not associated with significant environmental benefits, as it does not contribute to the reduction of virgin plastics production. It is widely acceptable that the plastic mix should be efficiently cleaned and sorted in polymer grades with well-defined properties, in order to be mechanically recycled to a high quality recycle. There is a great variety of technologies for this purpose, which gives the ability to sort the plastic stream, by polymer type, shape, colour, as well as additives such as flame retardants and mineral fillers (e.g. X-ray transmission imaging). However, many of these technologies are not commercially available -especially in the case of household plastics- due to their high cost. The automated sorting systems that are most commercially available are: the systems based on wet density separation, NIR spectroscopy and optical sorting techniques which can separate the mixed plastics by polymer type and/or colour. These technologies were successfully trialled in the UK yielding high purity polymer fractions. The manual sorting that is currently the practice that dominates in the UK’s facilities for dry recyclables separation, should be replaced by automated systems as it has significant operational costs and especially in the case of mixed plastics, the possibility of misidentification, as well as the time of the operation is expected to increase in comparison with a bottle-only stream.

The three potential processes -on which the operation of the plant could be based- briefly included the following treatment steps: process A separated the plastics into a film and a rigid fraction and then the rigid fraction by polymer type recovering 80.8% of the material; process B included the same steps as in process A and afterwards the main polymer fractions were further processed into flakes and pellets, recovering 67.52% of the material. Finally, process C only extracted the polyolefin fraction of the plastics and afterwards it was processed into polyolefin pellets. The film fraction was also extracted and baled. The recovery rate in this case was 62.06%. The economic evaluation illustrated that none of the processes is economically viable, as the current tonnage of mixed plastics arising from the company’s MRFs (6,000 tonnes) cannot ‘support’ the respective magnitude of investment. Process A is operating in profit in 50,000tpa and processes B, C in 40,000tpa. A sensitivity analysis with the aim of investigating the potential of the processes to
operate in profit, provided for e.g. that these will undergo several technical reconfigurations or the adoption of simpler mechanical treatment options should be further researched as they may lead to a viable solution. The analysis was not performed in the present study, to avoid the generation of misleading outcomes. The lack of accurate data significantly limits the ability to calculate the effect that the change of specific factors will have on the costs/revenues and can lead in considerable errors.

**Discussion, Conclusions and Recommendations:**

Further considerations on the company’s involvement in the field were discussed: the developing of a process that would treat the whole domestic plastic packaging waste (bottles included) and the active collection of the mixed plastic material. In both cases, it is likely that the tonnage needed to ‘support’ the investment will be available.

Additional benefits are that in the first case, as the bottle stream is more valuable, easier to handle and the markets for the outputs are well-established, the result will be an input material of significantly higher value, which its further processing will consequently have a greater potential; in the second case the company will ‘secure’ its current contractors and will easier gain new contracts as the Local Authorities are under pressure to collect the material.

On the other hand, the incorporation of the mixed plastics in the bottle-stream may have adverse market implications: the dominating tendency is for the recyclers to accept -if not only bottles-sorted and well-defined material streams by polymer type, shape and application (e.g. PP crates or PS cups) and currently high percentages of contamination are being reported by them. This fact highlights the need for the company to primarily preserve the quality of its bottle stream and be more cautious towards the adoption of a process that will simply sort the plastic mix by polymer type (and/or colour). The absence of more detailed official specifications complicates the situation (such as the DKR’s in Germany).

A solution may be to target the foreign markets, which appear to be more flexible in terms of quality, such as China; however, this situation may alter in the next few years. China -being a major importer- may address to alternative markets if the supplied quality is not improved and once the country will be covered by its domestic markets, specifications on waste imports will logically be stricter. A more appropriate solution may be the adoption of a hybrid process: the incorporation for e.g. of a sorter that will also identify the shape of the plastic container, can guarantee the quality of the bottle stream and gives the company the flexibility to address to a number of reproprocessors – in the UK or abroad.

In addition, a detailed market research is needed to identify especially the share that the mixed plastics can have in the plastic recycle market (even if they are properly sorted) which are currently dominated by the commercial sector. The domestic LDPE film, for instance, is uncertain if it can penetrate in the respective market, despite the fact that it is the most widely recycled type of packaging material in the UK with projected increase in future demand; the reproprocessors show a preference to the commercial ‘waste’, as it is a reliable source of both consistent quantity and quality.

Another issue under investigation should be the capability of the company’s MRFs to deal with the plastic mix – it should be noted that the great inconsistency that is currently reported in the collection schemes may cause additional operational difficulties; official guidance is in place but the communication of the message to the householders is not a straightforward task, due to the diversity of the plastic packaging items.
Regarding the development of the mechanical recycling route in the UK, the main barriers have been already discussed in relation with the negative implications that the company may face; in summary they include the inconsistency regarding the collected mixed plastic material, the lack of reprocessing infrastructure, the limited market demand and price for the output, as well as the potential of deterioration of the bottle-stream quality. Apart from barriers, there are also significant drivers that boost the development of recycling in the country, with the main of them being the legislative requirements (a target of 57% recycling rate for the plastic packaging is being discussed), the increasing public demand and the governmental capital support in the form of funded research projects, subsidies and recently with the Mixed Plastics Loan Fund.

In the context of the funded research projects, further work may be considered towards trials for the processing of the several polymer grades into final products to increase the use and state specifications of recycled grades as replacement of virgin plastic and to test their suitability for several end-use applications; a detailed market research on the specific demands of re-processors and manufacturers should also be considered. The feedback of the research, will lead to the establishment of clear standards for the plastic recyclates; the consequent result will be the increase of the recyclate value, the expansion of the markets and the facilitation of the trading process – a strong boost in the incorporation of the non-bottle packaging in the plastics recycling chain. The export of the material may also provide a suitable interim solution, as it will give time to deal with the existing barriers. However the country should not face the export markets as a permanent and necessary solution to support the recycling chain; if their rules alter in the future, a domestic mechanism must be in place to support the system.

Finally, considering the issue in a broader context than that dictated by the circumstances prevailing in the UK, alternative approaches can be formulated. The technical limitations posed by the complex nature of the material as well as examples from other countries clearly indicate that the capability of the mechanical recycling to deal with mixed plastics is overestimated. In theory the mixed plastic stream can be constantly recycled into high quality recyclate; in practice, however, the diversity of plastic packaging formats, additives and intrinsic plastic properties in combination with the high cost of sophisticated sorting methods, leads to the production of low quality recyclate that will be used in ‘downgrading’ applications, making no environmental (neither economic) sense. Feedstock recycling and energy recovery schemes are not blocked by the nature of the material, being promising alternatives. Germans, who are the European leaders in plastics recovery, are heavily depended on these options highlighting the need for an integrated strategy. The policy makers may therefore consider supporting the development of these routes along with mechanical recycling.

Under this context, the company may also explore the possibility of maintaining the current management route: the recovery of energy from the mixed plastic waste and investigating the option of converting the material into RDF, an environmental preferable route than ‘downcycling’. This approach may be proved economically viable in comparison with the assessed options; the feedstock recycling schemes cannot be considered at present as they are blocked by economic parameters, traditionally demanding substantial subsidies to operate in profit and such a mechanism is not in place in the UK.