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TECHNICAL R E P O R T

SMART TRASH

Study on RFID tags and the recycling industry

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Executive Summary

RFID technology is linked to recycling in two complementary ways. As objects, tags contain a variety of materials whose recycling is desirable on environmental grounds. These materials vary with the type of tag and their significance will increase as tags become more pervasive. Also, tags can themselves contribute to the efficiency and effectiveness of recycling at various stages in the lifecycles of a wide range of products, ranging from simple items to complex objects containing a variety of materials.

The risks arising from the first element (e.g. potential contamination of waste streams) and the opportunities from the second have been discussed or studied in specific contexts, but have not yet found general application. To provide an empirical evidence base for policy, this study aimed to:

- (1) clarify the issues and evidence relating to the environmental impacts and recycling methods of RFID tags;
- (2) assess the environmental advantages of RFID for product lifecycle management.

Each line of investigation had its own scope, time frame and policy context, but the overall analytic frame, the policy implications and the stakeholder engagement draws out their complementarity.²

With regard to the time frame, our analysis took account of the gradual development of impacts over time. As shown in Part A of our study, short-run developments affecting the recycling of RFID tags are likely to take the form of disseminating new ways to handle existing tags through detection, removal, sequestration and processing. Over the medium- to long-run, new forms of recyclable tag and methods of affixing them may be developed to permit all tags to be recycled and the mix of identification technologies may shift to reflect whole-life (including disposal and environmental) costs as well as performance characteristics. At the same time, the current differences in the spread of tags, which originate from the diversity of national contexts and the wide range of waste management systems in place, are expected to diminish through the alignment of Member State practices to a progressively implemented EU framework legislation.

² For example, initiatives aimed at introducing RFID tags to improve recycling will need to trade off the material challenges of recycling the tags against improvements in the effectiveness of recycling the materials to which they are attached.

As regards the use of RFID to improve recycling, Part B of our study found that short-run developments are likely to involve extending and “joining-up” existing pilots with other initiatives in the field of waste handling as well as the development of new methods for using existing tags, e.g., by the inclusion of new data useful in waste collection and disposal. In the medium term, deployment of RFID as part of improved waste handling may change user behaviour, business models and even sectoral organisation (e.g. emergence of intermediary markets for aspects of smart waste handling or changes in vertical integration along the End-Of-Life (EOL) product chain). In addition, policy may adapt to new possibilities, especially as regards traceability and waste stream measurement. Long term possibilities may include novel whole-systems approaches to waste handling and eventually new forms of integrated lifecycle management.

CONCLUSIONS AND POLICY RECOMMENDATIONS

It is still early days for RFID in the EOL phase of products. Applications are scarce and cannot rely on the presence of usable information on RFID tags attached to objects. In order to optimise benefits it is necessary to anticipate such uses at the design phase of the product, or its packaging.

Promoting a case by case approach: the ways current use cases deal with RFID tags vary with the purpose(s) for which tags are applied, whether they are active or passive and how they are used. The same considerations determine which parties in the value chain will innovate and invest and the scope of applicable law(s).

The nature and applications of RFID tags continue to evolve. While it is important to provide regulatory certainty to encourage beneficial developments, it is equally important not to inhibit or foreclose beneficial progress by legislating too soon, or by adopting inflexible rules tied too closely to specific technologies or use cases. The ‘overhang’ effect of such rules may prevent the development of new use cases and superior approaches, and may even distort technological innovation. Appropriate flexibility can be ensured by a wide participation in rulemaking and enforcement, *ex ante* assessments that take risks and opportunities into account in a range of technological and market scenarios and incorporation of adaptive monitoring and enforcement strategies to keep track of developments and impacts both within the EU and around the world. In addition, the optimal balance of commitment and flexibility will probably involve a mix of self- or co-regulation and formal regulatory measures, in cases where self-regulation fails or produces greater damage to competition and/or innovation. For example, RFID labelling of components of complex durable goods could increase their re-use, but is likely to be resisted by manufacturers. A proper establishment of a way forward should therefore take into account all stakeholders in the value chain and include the EOL phase into the value chain.

The balance between use-case and business model-specific approaches vs. (global) standardisation and general rules should be clearly defined in order to provide necessary regulatory clarity and certainty. Among the more specific issues areas for policy intervention or consideration, the following stand out.

- **1. A good understanding of where value is created and where it is captured in the value chain**, which can in turn provide a better understanding of where

investments are likely to be made and how they might be influenced by policy. As innovation and deployment entail high upfront investments as well as complex cost/benefit reallocations, effective policy must be sophisticated in its use of incentives and clear enough to reduce unnecessary or distorting risk.

- **2. Understanding and control the effects of RFID tags on waste:** the material content of RFID tags can affect the recovery of other materials. For instance, the aluminium antennas of RFID tags can reduce the amount and/or quality of recycled glass if they cannot be separated within the process. Solutions are most likely to be developed by those who apply tags to their products or packaging; this will vary across use cases. In suitable instances, the problem could be avoided by reengineering tag application or composition (for instance by incorporating them in removable labels and bottle caps rather than in the bottles or jars themselves). This approach requires the participation of stakeholders from the different recycling sectors. Development and deployment could be encouraged by self-regulation and use of “good practice” recommendations, or, if this fails, by legislation.
- **3. Technical requirements for RFID to become effective for EOL include:** the need to be accessible during the EOL phase, i.e. tags should continue to provide information even after objects enter the waste management process until the point where the information is no longer needed; ensuring that (relevant) information can be protected against reading by unauthorized parties; and reducing the environmental burden of tag disposal. Specific suggestions include: (i) development of reliable technology to support privacy requirements by removing tag information, or rendering it inaccessible or “masking” part of the information stored on the tag; (ii) development of tags that make minimal use of materials that might reduce the recycling yield material from the objects to which they are attached by means of printable electronics and methods for their effective removal when they would impair the recovery of materials they are printed on or process functionality. Printable tags have been under development for the past 5 years but have yet to be reliably implemented.
- **4. Privacy and security** was frequently highlighted as an important consideration; concerns may be addressed by giving individuals a clear opportunity to choose RFID tags that are removable or contain a kill or partial kill-switch. Alternative solutions may be encouraged by clearly allocating responsibility for properly addressing these challenges to specific players in the value chain (such as tag producers or tag users), either through regulation or self-regulation. However, in this there is clearly a need for a more careful consideration of ways to avoid ‘over-protection’.

There is a need for a broad societal debate on the general use of RFID, with a clear attention to its potential societal contribution throughout object life cycles. This debate, which must involve both technical experts and citizens must seek to understand (1) functionality, how – and for what purposes – tags are (and may be) used; (2) what might happen as a result and (3) how these consequences will affect our behaviour and welfare. Considerations stemming from use of RFID should also play a prominent role in broader debates about security and privacy; failure to do so may particularly distort future applications of RFID – and in the process

lead to potentially worse outcomes from both the privacy/security and environmental standpoints.

- **5. Mandating the tag-based or on-line accessibility of environmental information:** identifiers stored on tags could promote environmental and privacy-conscious informed consumer choice and thus encourage better recycling of certain materials or objects. It may be necessary to make this mandatory (in the spirit of the Energy-related Products Directive) in order to minimise distortion and to align market incentives (e.g. competition on the basis of recyclability) with environmental objectives by reaching the required level of prevalence.

Finally, the relations between RFID and waste are still in their infancy; there is a long way to go to: build necessary awareness; assess the technical, legal and commercial feasibility of new approaches; and stimulate interest throughout the value chain (e.g. RFID designers' and manufacturers' interest in end-of-life uses of the chips they supply and the waste sector's willingness to engage with product design and deployment). Overall, the prospects are good; interest throughout the product life-cycle is likely to grow as technology advances and waste management becomes more important. In particular, interest in RFID-aided recovery is expected to increase as material scarcity or prices increase.

This establishes the need for continued improvements; it does not mean that they will occur automatically. The evidence gathered through the literature review, use case and case study analysis and the public consultations identify a range of specific barriers that must be removed if the full potential of RFID in waste treatment is to be achieved. Most of these involve industrial and other private sector stakeholders, but they will only act effectively if the framework conditions are right. In order to create the appropriate regulatory, legal and economic conditions, the European Commission needs to take action to address the following issues.

- The availability of suitable innovation and investment capital – and the willingness and ability of stakeholders to develop integrated technical and business models viable throughout the value chain – are inhibited by legal and regulatory uncertainty, especially as regards liabilities for waste streams and their treatment, and the welter of potentially-applicable Directives and other regulations. This uncertainty can be greatly reduced by a rationalisation and harmonisation of the relevant rules. In particular, the European Commission may wish to specify whether RFID tags fall under a single legal instrument or multiple frameworks (including e.g. the new Waste Electrical and Electronic Equipment (WEEE) Directive). In the latter case, the application of the various Directives should be clarified by a series of Delegated Acts or other instruments to give force to their requirements in a coherent and consistent way in specific RFID-enabled waste treatment contexts.
- The extension of economic connections throughout the product life cycle creates opportunities for reuse of information provided or recorded on RFID tags attached to disposable products to assist in the (re)design and handling of those products and to shed light on the behaviour of stakeholders and the performance of the waste sector. This potential calls for the development of new business models.

- RFID tags, the objects to which they are attached and the disposal facilities for which they are ultimately destined are spread across the globe. The sustainability of improved performance within the European Union and the dissemination of good practice and awareness originating in Europe throughout the global economy call for high levels of interoperability; this in turn is made more efficient and friendly to competition through the development of global standards. The European Commission can support global standardisation (e.g. as to the content and format of stored information) both by direct participation in standards bodies and by the incorporation of standardisation requirements into R&D and economic development programmes and into public procurement tender requirements.
- As noted above, the issues with which this report deals arise in the very beginning of the product life cycle but develop their impacts at the very end. This separation of (design and deployment) decisions from waste handling practices is a powerful barrier to consistent, sustainable and joined-up progress. The barrier is lower in some use cases than others; e.g. business processes relating to the end-of-life of specific products like electric and electronic equipment and vehicles where dedicated legal instruments (WEEE and End-of-Life Vehicle (ELV) Directives) impose costs on manufacturers and designers. The same cost- and responsibility-sharing principle can be extended to other areas by extending end-of-life responsibilities on manufacturers with the explicit provision that these responsibilities can be discharged by use of 'disposal-friendly' RFID tags. The feasibility of such provisions would be enhanced by audit information available from tag readers within the waste sector.
- Privacy and data protection issues rank highly among the 'soft' barriers to wider RFID adoption and in particular to the use of identification technologies in waste disposal policies (from simple tracking to economic incentive schemes). The EC can take action to ensure that the specifics of this use of RFID technology are taken into full account in the ongoing revision of data protection rules and associated parts of the regulatory framework and in developing the governance framework for the Internet of Things of which RFID tags play such an important part.