The Checklist
This checklist provides a quick reference guide to help you make more informed sustainability decisions for smart packaging. Before you begin, ask yourself:

- How can smart packaging impact the sustainability goals of my company and customer?
- How can smart packaging drive more sustainable and circular packaging designs?
- How could the materials in my smart packaging adversely impact recovery?
- Do I have all the information I need to make the right choices?

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## SMART PACKAGING

### SAFETY
1. Does the smart packaging pose any risks toward human or environmental health?
2. If the smart packaging substrate uses precious metals (e.g., silver) are there concerns regarding leaching of components in landfill or recycling facilities?
3. If used for food applications, is the material approved for direct or indirect food contact?
4. Does the smart packaging use lithium batteries? Do they represent a safety risk as a potential heat source after use?
5. Are there extra materials or components that are unnecessary?

### REUSE and RECYCLABILITY

1. Is the smart packaging or material recyclable or non-recyclable? Reusable or compostable?
2. Is the smart package designed for disassembly or for product & package compatibility? Is the packaging unnecessarily complex?
3. Can the smart package include the capability to be scanned or recognized by consumers or MRF’s to facilitate better sorting of materials?
4. Does the packaging clearly identify the material(s) used? Is it marked with the revised plastic resin identification code, where applicable?

### SMART FUNCTIONALITY

1. Does the smart packaging provide an added benefit or better experience (product tracking, traceability, authentication, consumer/retailer interaction, how to recover and recycle)?
2. What tools will the consumer or retailer need to access the product information? (e.g., mobile phones, smart watches / wearable, smart appliances / scanners)
3. Does the smart packaging inform the consumer about the interactivity / how to engage?

- **Consider** impacts throughout the packaging value chain, including at Material Recovery Facilities (MRFs), where materials are sorted for recycling.
- **Check** with industry sources to understand potential recycling impacts e.g., the Association of Plastic Recyclers (APR), the Institute of Scrap Recyclers Industries (ISRI), Biodegradable Products Institute (BPI), intelliPACK
- **Design for disassembly** for packaging with multiple components, including retail displays and other promotional packaging, in order to increase chances of packaging being successfully and safely recovered.
- **Design for compatibility** – it may be possible to select materials that are the same as the primary package to enable recovery and recycling.
- **Monitor** emerging technology that would allow smart packaging to assist with improved recycling sorting of materials (e.g., digital watermarks). Refer to the intellipack website for updates.
- **Communicate to consumers** what to do with each packaging component at the end of life. (Refer to How2Recycle program and local WEEE program)
Does the packaging include use of smart inks (light or heat sensitive) or adhesives that may compromise the value of recycled materials?

Do the printing inks, adhesives or coatings used raise any concerns? (leaching into materials / environment)

Ensure selected inks & pigments (for labels and paper substrate) do not bleed in water as this may degrade the quality of recyclate. Also check that barrier coatings and label adhesives used are recycling friendly (refer to APR - Association of Plastic Recyclers Design Guide for Plastics Recyclability and Bleeding Label test).

For food packaging, test to ensure that ink chemicals do not migrate into the contained product. Smart inks are often used to improve food safety and to help reduce food loss & waste.

Where feasible, design all of these items for recyclability (common materials to primary packaging) so that the entire package can be recycled.

Design the package for dis-assembly for easy removal of labels, strips, films to minimize contamination of the primary packaging.

Use body sleeves that are compatible with recycling, use perforations to encourage removal or have de-seaming adhesives that enable easier sleeve removal (APR Critical Guidance Test for Sleeve Labels).

Where labels and sleeves cannot be removed from the primary package ensure that they comply with APR guidelines for substrates and adhesives to minimize contamination of high value recyclable materials (HDPE, PET)

Design the package for dis-assembly – easy removal of the sensors and tags to minimize contamination of the primary packaging. Understand options to ensure safe disposal or recycling of components. RAND report (see Additional Resources) indicated that likely best option is for RFID tags to be disposed of with WEEE (Waste Electrical & Electronic Equipment).

Design the sensors and tags for recyclability so that the entire package can be recycled. For example, some paper based RFID tags may be recycled with the corrugated or paper stream. Where possible use certified paper sources e.g. FSC certified. Consider eco friendly hot melt adhesives and alternates to metal antennas.

Follow latest technology developments for environmentally friendly tags e.g. Smartrac.

Refer to industry standards for printed electronics IPC Association Connecting Electronics Industry, ASTM electronics standards, IEC - International standards for printed electronics.

The Smart Packaging Sustainability Checklist was developed in collaboration with intelliPACK: a partnership between PAC and intelliFLEX.
REFERENCE TOOLS IN MARKET EXAMPLES

QR Codes/Bar Codes:
- Provides a unique product identity for traceability, authenticity and consumer loyalty.
- Allows for smartphone camera scan and access to Internet information.
- QR codes can be scanned by any smartphone to provide product information and confirm authenticity.

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Modified Atmosphere Packaging (MAP):
- In combination with barrier films or added strips helps extend fresh produce shelf life.

Digital Watermarks:
- Covertly embedded directly into the print design of a package. Codes are unique and scanned by smartphone to provide product information and confirm authenticity.

Augmented Reality:
- Uses technology to superimpose virtual reality onto packaging to improve branding, interactions with consumers.

Smart Packaging often involves adding an additional element to the existing packaging that can impact the recyclability of the package.

QR Codes/Bar Codes:
- Provides a unique product identity for traceability, authenticity and consumer loyalty.
- Allows for smartphone camera scan and access to Internet information.
- QR codes can be scanned by any smartphone to provide product information and confirm authenticity.

Active tags have a local power source (such as a battery) and can operate hundreds of meters from the RFID reader. Passive tags collect energy from a nearby RFID reader’s interrogating radio waves. NFC tags can be read by a smartphone when in close proximity (ca. 4cm)

Smart Inks/Pigments:
- React to changes in the environment (heat, cold, UV light) and can enhance package branding, indicate freshness and quality.

RFID Tags:
- An electronic tag that exchanges data with an RFID reader through radio waves. Passive tags collect energy from a nearby RFID reader’s interrogating radio waves. Active tags have a local power source (such as a battery) and may operate hundreds of meters from the RFID reader.

NFC Tags:
- Near Field Communication is a subset of RFID that facilitates consumer interaction (e.g., logistics and supply chain tracking with an RFID tag) as the NFC tag can be read by a smartphone when in close proximity (ca. 4cm)

RFID Tags and the Recycling Industry: The study, funded by the European Commission, aimed to obtain expert input necessary for assessing (i) the environmental impact of RFID tags and (ii) the environmental advantages that RFID can provide for product lifecycle management.

The Future of environmentally friendly NFC tags:
- gototags.com/blog/the-future-of-environmentally-friendly-nfc-tags/

IN MARKET EXAMPLES

Smart packaging plays an important role in preventing food waste. Some fresh produce packaging features micro-perforated lidding film and gas permeable labels that help extend shelf life such as an extra 12 + days for tomatoes, while maintaining the recyclability of the packaging.

Smart packaging equally plays an important role in product traceability, authenticity, anti-counterfeiting and product & package information. In this example for pharmaceuticals a smartphone and an accompanying app reads the QR code on the CapSeal cap, which is then compared with a database to determine the authenticity of the product within seconds.

ADDITIONAL RESOURCES

Designing environmentally friendly smart packaging: RFID has the potential to be a significant enabler in the recycling of various types of products according to ISO/IEC TR 24729-2:2008 iso.org/standard/41882.html. The standard is also concerned with the prevention of solid waste generation by the tags themselves. Proper disposal is especially needed for active tags, since their internal power source is often a lithium battery.

RAND Europe published a report in 2012 “SMART TRASH - Study on RFID tags and the Recycling Industry” The study, funded by the European Commission, aimed to obtain expert input necessary for assessing (i) the environmental impact of RFID tags and (ii) the environmental advantages that RFID can provide for product lifecycle management.

The Future of environmentally friendly NFC tags:
- gototags.com/blog/the-future-of-environmentally-friendly-nfc-tags/

Design for Recycling
- PAC NEXT structural packaging sustainability checklist provides a quick reference guide for better packaging design sustainability decisions.pac.ca/Programs/Next/Documents/pac-packing-sustainability-checklist-structural.pdf
- Association of Plastic Recyclers (APR) Design for Recycling Guidelines for plastics packaging: plasticsrecycling.org/apr-design-guide/design-guide-resources
- Inks (Nestle Guidance on Packaging Ink, August 2016) argus-analysen.de/assets/plugindata/poola/nestle-guidance-note-on-packaging-inks-2016-08.pdf

TRADE-OFF CONSIDERATIONS

What if the use of smart packaging results in trade-offs or unintended consequences (e.g. higher costs, less recycling, poorer brand positioning)?

It is important to align and integrate your smart packaging decisions into your mainstream package design and development program and to understand upfront the potential trade-offs on costs, efficiencies, brand connectivity or product benefits communication and sustainability. Focus on how the smart packaging can enhance your long term sustainability goals and through collaboration and innovation your chances of success will increase.

How do I balance sustainability with important smart packaging considerations?

The answer here is to take a holistic approach, in most instances smart packaging will improve product and package sustainability by extending shelf life, reducing loss and wastage, increasing logistics efficiencies and providing more useful product and brand information to consumers more readily through smart devices.

RECYCLING WATCH OUTS

Smart packaging often involves adding an additional element to the existing packaging that can impact the recyclability of this package:

Smart Material choices: Common package materials (PET, HDPE, LDPE, PP, Paper, Carton) are more likely to be accepted at curbside collection programs. Matching smart materials with primary package materials will avoid contamination issues and retain the higher value of the primary recyclable material.

Smart Label, Films, Sleeves: Where feasible design all of these items for recyclability so that the entire package can be recycled.

Smart Inks & Pigments: Ensure ink bleed tests are conducted to avoid any potential contamination of plastic and paper recycle.

Lithium Batteries: Where feasible should be easy to remove from the packaging and disposed of separately. They represent a potential safety risk in MRF’s if compacted in bales of flammable materials.