Position Paper WG2 ActInPak

Market Implementation of Active and Intelligent Packaging – Opportunities from a socio-economic perspective

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Abstract

The pan-European multidisciplinary network ActInPak recently identified the key social, technological, economic, ecologic, and legislative factors that hinder the market introduction of Active and Intelligent Packaging (AIP) technologies for fibre-based packaging. As a result, this Position Paper specifically reflects on potential implementation of AIP from a socio-economic point of view, addressing aspects related to the interaction between component producers, packaging producers, packers, brand owners, retailers and consumers. This paper presents the main overarching findings that are to be most influential in successful market implementation on socio-economic level: i) gap between science and industry, ii) cooperation between the producing stakeholders within the value chain, iii) gap between industry and consumer, and iv) market drivers that affect developments. These main findings are all on a higher level, linking the detailed challenges in the socio-economic roadmap, and supporting the overall Final Roadmap produced by ActInPak to direct future activities in the field.

Keywords

active packaging, bioeconomy, fibre-based packaging, intelligent packaging, market implementation, roadmap, socio-economic

1 Introduction

A packaged product maintains its quality longer – without packaging, the product would lose its value or nutritional components. Packaging also informs the consumer how long they can keep using it. To even better protect or inform, *active and intelligent packaging* are developed.
Active packaging prevents spoilage by influencing the environment within the packaging. By using natural fungi repellents in the cardboard, for example, there is no need for chemical treatment of your food1-2. Intelligent packaging continuously checks the condition of your product and the environment around it. In this way you can, for example be sure it was at the right temperature from the packing moment all the way to your fridge3-4. *Active and Intelligent Packaging* (AIP) are not only for food5-6, they can keep flowers fresh, ensure that high value products such as electronics or cosmetics are what they claim to be and inform us that our medicines are genuine. Thinking about the whole package, AIP can prevent a lot of waste throughout the value chain7.

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Bioeconomy is based on the shift from fossil to renewable raw materials to respond to the challenges of climate change, ecological scarcity and depletion of natural resources. Packaging plays an important role in the bioeconomy. The demand for high quality active and intelligent packaging concepts is constantly increasing. Most of the current AIP solutions are plastic-based, so there is a clear demand for renewable and sustainable solutions to create new packaging materials and concepts. The use of bio-based materials in packaging decreases the dependence on fossil fuels. Wood based biomass that is available in a large scale offers attractive "green" polymers. Also biopolymers that are based on agricultural or other waste streams offer interesting alternatives for traditional petroleum-based polymers.

2 Goal of the research

Developments of new fibre-based packaging materials with active and intelligent features offer huge potential, as AIP can help to optimise the supply chain, increase (food) shelf life and consumer consciousness of (food) utilisation, as well as introduce interaction between producer and consumer8-9. However, very few of the potential and existing solutions currently have been able to reach the market. To identify the key social, technical and technological, economic, ecologic, and legislative factors that hinder this market introduction, COST Action FP1405 Active and intelligent fibre-based packaging - innovation and market introduction (ActInPak) was established in 201510-11. Within this multidisciplinary platform, both science and industry gathered to gain insights in the barriers towards market introduction of AIP in fibre-based industries.

3 Execution of the Research

During its lifetime, ActInPak provided a platform for open communication, linking i) research organisations in the areas of papermaking, packaging, printing, bio-based materials/ chemicals, ii) industry (large and SMEs), and iii) branch organisations and policy/ standardisation groups. This platform was created by organising various meetings, workshops and conferences on topics that mattered during that period of the Action. Both Invited Experts (from science as well as industry) and ActInPak participants presented their views to direct the network's activities.

4 Results andconclusions

Results and insights are bundled in several publications12 with varying goals, but all ActInPak insights and results are consolidated in the Final Roadmap13 (figure 1) to direct future activities. This Final Roadmap has several layers; sustainability, technological, and socio-economic with different interests and prospects for different stakeholders. Additionally, a separate roadmap only focusses on socio-economic aspects, meaning it only addresses aspects relating to the interaction of social and economic factors – in the case of AIP, industry (that needs to implement AIP) and consumers (that use AIP). This socio-economic roadmap14 is pictured in figure 2.

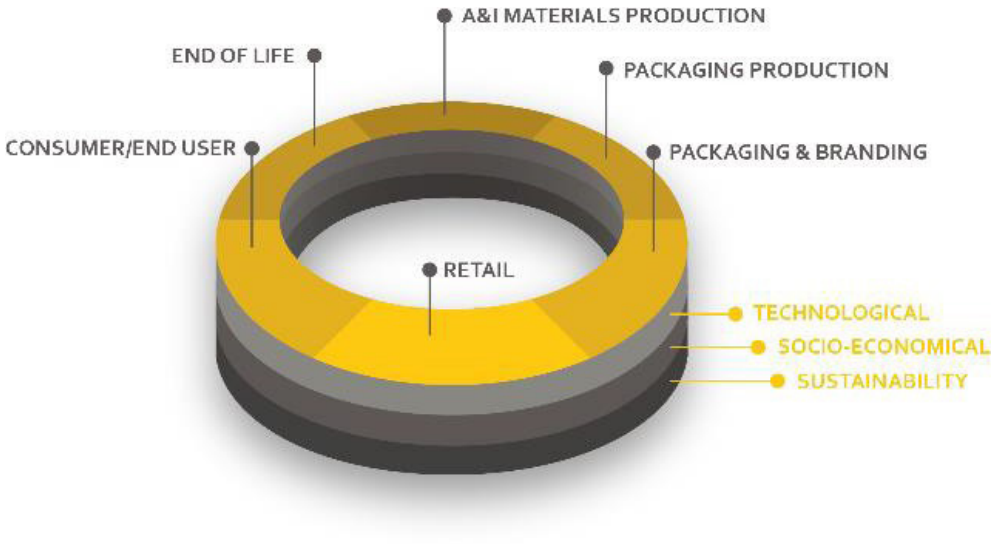

Figure 1. The final overall ActInPak roadmap.

This Position Paper does not reflect on AIP technologies, but on potential implementation of AIP in general from socio-economic point of view. It presents the following main overarching findings that are to be most influential in successful market implementation on socio-economic level: i) gap between science and industry, ii) cooperation between the producing stakeholders within the value chain, iii) gap between industry and consumer, and iv) market drivers that affect developments. These main findings are all on a higher level, linking the detailed challenges as mentioned in the socio-economic roadmap.
Finally, this paper will discuss approaches towards the future that could be the start of new working groups actively addressing implementation in industry.

	A&I COMPONENTS PRODUCER	PACKAGING PRODUCER	PACKER / BRAND OWNER	RETAILER	CONSUMER / END USER
CHALLENGES	Dependency Costs versus revenues Availability Legislation	Awareness Costs versus revenues Availability Legislation	Awareness Costs versus revenues Availability Trust in technology Legislation	Awareness Costs versus revenues Transparency Trust in technology Reliability Legislation	Awareness Costs versus revenues Trust in technology Perception Way of communication
MARKET DRIVERS	Sustainable goes mainstream E-commerce Technological development Legislation	Sustainable goes mainstream E-commerce Technological development Legislation The internet-of-things	Sustainable goes mainstream Competitive value Production E-commerce / the internet-of-things Personalisation	Benefits Retail spaces become brand experience spaces Consumer behaviour E-commerce / the internet-of-things	Sustainable goes mainstream Gen-Z Changing consumer needs Engagement Hi-tech Adversity
SHORT TERM (NOW-2020)	**SOLUTIONS** » Increase shelf-life to reduce food waste » Packaging improvement » Raise awareness of packaging producers » Educational strategies for packaging producers **ENABLING TECHNOLOGIES** » Market-ready technologies as currently developed » New, green processes to obtain A&I components **RESOURCES** » Production facility » Process knowledge » Green chemistry knowledge » Legislation	**SOLUTIONS** » Increase shelf life to reduce food waste » Packaging improvement » Packaging interaction with the consumers » Raise awareness of packers/brand owners » Educational strategies for packers/brand owners **ENABLING TECHNOLOGIES** » Market-ready technologies as currently developed » New, green processes to integrate A&I **RESOURCES** » Multidisciplinary approach » LCA » Specific treatment after-life packaging » Legislation	**SOLUTIONS** » Create awareness » Identification of market-ready technologies » Build business cases to identify market opportunities » Flexible risk assessment methods for compliance **ENABLING TECHNOLOGIES** » Market-ready technologies as currently developed » New, green processes to integrate A&I **RESOURCES** » Investments to modify the existing production process » Raise awareness to resolve investment decisions » Raise awareness of the technologies in the whole value chain » Raise awareness of the food waste issue and find strategic partners	**SOLUTIONS** » Communication to customers in-store » Get feedback from consumers » Train employees » Prove practical application through usefulness » Make strategies specific for target groups » Create trends in AIP » Lobby for support from related industry groups **ENABLING TECHNOLOGIES** » Integration with new non-packaging technologies (AR, smart fridges, shopping via Alexa, ...) » Determine the need for staff >> training plan **RESOURCES** » Trained staff » Prepared stores (shelfing, special space and place) » Communication measures » ROI matrix to explain the change in sales	**SOLUTIONS** » Educate customers about AIP » Latest concern or food scare does not stay in consciousness for long » Inform via advertising / social media » Start using AIP in common products and with big brands **ENABLING TECHNOLOGIES** » Social media advertising » Mobile phone interaction with labelling **RESOURCES** » Home deliveries with amazon » Kids are nowadays decision makers regarding what to buy » Information campaign about products, food waste, new technologies » Social media, videos to spread information
MID TERM (2020-2025)	**SOLUTIONS** » Lower costs due to increased production and technological development » List of approved active compounds in packaging » Collect more data to get compounds to be approved **ENABLING TECHNOLOGIES** » New (green) materials » New (green) processes **RESOURCES** » Knowledge and Technology transfer from science to industry	**SOLUTIONS** » Tax food waste » Simplify legislation **ENABLING TECHNOLOGIES** » New (green) materials » Flexible processes **RESOURCES** » Knowledge and Technology transfer from science to industry	**SOLUTIONS** » Cooperation with academic society » Government funding » Database of market ready technologies » media promotion of AIP **ENABLING TECHNOLOGIES** » Upgraded sensors » Smart shops » Smart household equipment **RESOURCES** » Social media promotions	**SOLUTIONS** » Willingness to pay for AIP by the consumer » Easy and clear communication » Consumer perception » Consumer interaction » Keep up with consumer trends **ENABLING TECHNOLOGIES** » Specific packaging for different consumers i.e. disabled people » Communication / dissemination activities **RESOURCES** » New electronics to support AIP retail	**SOLUTIONS** » Engage early adopters in educational campaigns » Tailoring AIP for packaging and consumer needs **ENABLING TECHNOLOGIES** » New communication channels **RESOURCES** » Influencers, e.g. bloggers
LONG TERM (2025-2030)	**SOLUTIONS** » Continuous development of new and safe A&I components for specific purposes » High throughput testing technologies » Shorter time from application to approval of safety of compounds **ENABLING TECHNOLOGIES** » Move industry production from SMEs (low batch sizes) to large companies (large production runs) increasing availability **RESOURCES** » Knowledge and Technology transfer from small industry to large industry	**SOLUTIONS** » More strict legislation about food and packaging safety **ENABLING TECHNOLOGIES** » Optimised and flexible production processes capable to match all ranges of needs (also lower batch sizes) **RESOURCES** » Knowledge and Technology transfer from small industry to large industry	**SOLUTIONS** » Cooperation with academic society » Government funding » Database of market ready technologies » Media promotion of AIP » More strict legislation about food and packaging safety **ENABLING TECHNOLOGIES** » Smart houses and household devices » Digitalisation » Technologies for IoT and resources **RESOURCES** » Integration with other industries and services to create Smart Homes	**SOLUTIONS** » Reduce food waste and food spoilage » ensure storage conditions cold chain » ensure quality and safety of food product and package **ENABLING TECHNOLOGIES** » Integration of smart houses and smart packaging: the house works for you; food scanned, app telling when your food is spoiled (continuous tracking) or when perfect to eat **RESOURCES** » Integration with other industries and services to create Smart Homes	**SOLUTIONS** » Discounts for pre/early shopping online (better planning >> better prices) » Rewards for sustainable buyer behaviour (food and material waste reduction) **ENABLING TECHNOLOGIES** » Target next generation (instead of traditional) in shops and innovation » Price of AIP comparable to conventional products » Good recyclability of AIP » Afraid of being manipulated by producers or retailers **RESOURCES** » Strategic partnerships

Figure 2 – Socio-economic roadmap (a bigger and more detailed version can be downloaded on http://www.actinpak.eu/roadmap-wg2/)

i. Gap between science and industry

The first finding that hinders successful market implementation, is the gap between science and industry. Where science works for at least 20 years on active and intelligent packaging considering the number of scientific publications in those fields15 , the term is relatively new to industry in general. There is a lack of awareness and knowledge on AIP, its benefits, added value, function, and impact16-17. Scientific publications will not help in this regard, so communication targeted towards industry including the information they want to have is needed. This implies that information that is shared provides the big picture; what is it, how can it be used in the company, how much will it cost, what are the benefits. Not focused on partial solutions, but focused on fleshed out situations that also show the different scenarios and targeted applications (e.g. bulk versus unit, or high value specialty products).

Related to this, it is important to discuss opportunities for AIP technologies with different people inside companies, so not only engineers but also marketing and design departments for example. When presenting a new AIP solution, it would be good to have a "proven" demonstrator to show the potential of the solution[18].

ii. Cooperation between the producing stakeholders within the valuechain

The identified value chain runs from A&I components producer, via packaging producer to packer/brand owner and retailer towards the consumer/end user. It is very important (and challenging) to identify the whole value chain of the product in concern, and try to identify who are the key decision-makers[19].

Almost all challenges that were identified to be affecting successful market implementation of AIP, can be found to be an issue for one or more stakeholders throughout the value chain. So there is basically an interconnectivity between the stakeholders in form of mutual challenges, even though the details of the challenges differ. Furthermore, almost all of these recurring challenges trace back to cooperation and communication on different levels within the value chain, as well as inter sectoral.

Looking at a challenge such as costs versus revenues, it is clear to realise that for some stakeholders this means they have to get something in return for investing money in novel, more expensive, materials20-21. A value chain approach argues that the benefit of active packaging can be found in reduced food loss and waste, and for intelligent packaging this benefit lies in more proved safety or interaction between different parts of the value chain. This reduction implies that less products have to be packed (equalling lower production). However, since the actual costs of food loss and waste occur elsewhere in the value chain, the packaging producer and the brand owner are affected by lower production as this equals lower sales and thus profits for them. With the right marketing or additionals[22-23], this could be overcome.

Another example that shows the need for a good cooperation within the value chain is the challenge of availability, where production size does not match demand or where materials cannot be further developed or adjusted to unknown needs as behaviour and interaction are not yet known. Currently this challenge runs like a vicious circle between different stakeholders; A&I components producers at first instance are not able to produce tons of their components as they wish to validate it first. In turn, packaging producers are often not capable of running validation trials with small amounts or are not willing to try without clear proof that there is a market for it. However, to proof the market potential a trial is needed[24].

Conflicting interests can create boundaries, however to move forward it is important to find common ground to work on.

iii. Gap between industry andconsumer

Once there is a successful incorporation of active or intelligent features in packaging, one could think it is an automatic success in the market. However, ActInPak has also clearly identified that there is currently a gap between industry and consumers hindering a successful market introduction[25-26-27-28-29].

Again, there is a lack of awareness, so informing and educating consumers might prove to be beneficial. In basis, it is important that the AIP features are not too complicated for a consumer to understand. There should not be room for misunderstanding30. However, the way in which the information is presented, will also affect consumer trust31. For example, unknown and invisible extra features in a packaging (e.g. an active barrier coating that releases substances to the packed food), are perceived as suspicious and benefits might be unknown and unclear. People will doubt the safety and healthiness of the packaging, and turn to alternatives. Also, extended shelf life often is perceived as less fresh. However, if the communication would clearly stress the fact that through such a packaging, which is totally food safe the food is more natural, because chemical preservatives can be omitted, consumers might be inclined to pay the extracents[32].

One could also argue to which extent a consumer will have blind faith in technology and thus turns to companies in cases that went wrong[33], or whether the consumer will still use its own senses and common sense.

More research is needed in this area to explore the perception of different consumer groups, such as elderly[34].

iv. Market drivers that affect developments

Global trends like urbanisation and changes in population structure are considered more and more in packaging development[35-36]. Goods are increasingly transported, which requires durable packages maintaining at the same time the shelf-life of the product. According to UN, people aged over 60 will constitute more than 21% of the world's population in 2050[37].

Nowadays, the main trend in material development is sustainability (including circular and bioeconomy). Many brand owners and food manufacturers position sustainability as a key factor in their strategy, which "forces" them to look for sustainable alternatives for traditional packaging materials and solutions. On the other hand, consumer's awareness is all the time increasing and consumers "demand" more sustainable solutions (as witnessed by current events such as Doha and climate marches, and no-waste approaches by consumers).

In the paper and board industry, producers are trying to develop materials that have similar or improved characteristics compared to plastics to act as a replacement for non-renewable materials[38-39]. The resulting packaging materials are in such a shape that they actually maintain the quality of the food and prevent food losses and waste better than current paper-based packaging materials. As this is one of the aims of active packaging, viewing this solely from a 'improving shelf life' point of view, this means the need for active packaging materials disappears.

Furthermore, as barrier materials are created anyhow to increase the competitiveness of the fibre-based sector compared to plastic packaging industry, those barrier materials are cheaper or at least easier to finance than incorporating additional active features. In most cases, infrastructure and processes of packaging production need to be adapted to be able to work with active materials.

However, market drivers such as the internet of things (IoT), are easy to address with intelligent packaging features. This way, it is possible to create a full shopping experience where the fridge is informed by the packaging when it needs to be reordered so the consumer does not even have to think about it (just open the door when the delivery is made). Intelligent packaging features also offer brand owners interesting opportunities through consumer engagement and data collection[40].

5 Summarizing recommendations for futureresearch

Although it is tempting to try and make recommendations for AIP in general, viewed from a socio-economic market implementation perspective it is more logical to separate active and intelligent packaging into two categories as they have different purposes that have different implications.

In generic terms, **intelligent packaging** can be used for either i) communication to establish any brand-consumer connection, or ii) to inform about the product quality. Intelligent packaging offers many opportunities with the growing digitalisation relating to e.g. product safety, product location and product loss.

Mainly the first example is already widely used on the market, and therefore the challenges are relatively low. Reason for this is that the most commonly used intelligent features are labels and thus add-ons to a packaging, so there is less need to change current infrastructure or processes. Furthermore, extra costs for these features are often paid by marketing budgets and they pay off via consumer engagement and repeated buys. Consumers buy these type of packaging because they like it. However, in cases of printed electronics, implementation in roll- to-roll processes will need more changes.

The second example, where the focus is more related to product quality and less to consumer engagement, is more difficult to implement. Main reason for this is the fact that these features try to make the value chain transparent for the consumers by informing them if the quality of the product was compromised. These products might lead to profit losses at retailers, causing fear to actually use it. It might also result in fear at consumer level, instead of grown confidence.

Active Packaging is proven to be more difficult to implement in business to consumer environments for multiple reasons, such as incorporation in current infrastructures, the costs of investment, the different stakeholders with different benefits, and the consumer acceptance. More importantly, it is a question whether active packaging developments are still spot on when looking at current market drivers and global megatrends.

This does not exclude the fact that active features are beneficial to add to a packaging forextra features on top of the need for improved quality (which can be reached by novel barrier materials). For example in cases where preservatives are added to the packaging material, so the packed food can be as natural as possible.

Overall, it is recommended that for a successful market implementation of AIP, a holistic perspective is beneficial, including technological, sustainability and socio-economic aspects, as well as a value chain approach.

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References

[1] Yildirim, S.; Röcker, B.; Pettersen, M. K.; Nilsen-Nygaard, J.; Ayhan, Z.; Rutkaite, R.; Radusin, T.; Suminska, P.; Marcos,B.;Coma,V.,ActivePackagingApplicationsforFood.ComprehensiveReviewsinFoodScienceandFood Safety 2018, 17 (1),165-199.

[2] Vilela, C., Kurek, M., Hayouka, Z., Röcker, B., Yildirim, S., Dulce C. Antunes, M., Nilsen-Nygaard, J., Kvalvåg Pettersen, M., Freire, C., A concise guide to active agents for active food packaging. *Trends in Food Science & Technology* **2018**, Volume 80, 212-222.https://doi.org/10.1016/j.tifs.2018.08.006.

[3] [3]Hempel, A.; O'Sullivan, M.; Papkovsky, D.; Kerry, J., Use of smart packaging technologies for monitoring and extending the shelf-life qualityof modified atmosphere packaged (MAP) bread: application of intelligent oxygen sensors and active ethanol emitters. Zeitschrift für Lebensmittel- Untersuchung und -Forschung A 2013, 237 (2),117-124.

[4] Yam,K.L.;Takhistov,P.T.;Miltz,J.,IntelligentPackaging:ConceptsandApplications.JournalofFoodScience2005, 70 (1), R1-R10.

[5] Biji, K.; Ravishankar, C.; Mohan, C.; Srinivasa Gopal, T., Smart packaging systems for food applications: a review. Journal of Food Science and Technology 2015, 52 (10),6125-6135.

[6] Lee, S.; Lee, S. J.; Choi, D.; Hur, S. J., Current topics in active and intelligent food packaging for preservation of fresh foods. In J. Sci. Food Agric., 2015; Vol. 95, pp2799-2810.

[7] Schaefer, D.; Cheung, W. M., Smart Packaging: Opportunities and Challenges. Procedia CIRP 2018, 72 (C),1022-1027.

[8] Smithers Pira. (2016). Future of Smart packaging to 2021. Retrieved from http://www.smitherspira.com/news/2016/march/smart-packaging-trends

[9] Miguel A. Cerqueira, António A. Vicente, Lorenzo M. Pastrana, Chapter 1 - Nanotechnology in Food Packaging: OpportunitiesandChallenges,InMicroandNanoTechnologies,NanomaterialsforFoodPackaging,Elsevier,2018, Pages 1-11, ISBN 9780323512718,https://doi.org/10.1016/B978-0-323-51271-8.00001-2.

[10] www.actinpak.eu

[11] https://www.cost.eu/actions/FP1405/#tabs|Name:overview

[12] http://www.actinpak.eu/category/publications/

[13] http://www.actinpak.eu/roadmap/

[14] http://www.actinpak.eu/roadmap-wg2/

[15] Yildirim, S., WG1 Development/innovation, presentation during ActInPak Fair and Conference 'Active and Intelligent Packaging on Display', 21 November 2018, Vienna, Austria.

[16] Andrew Manly (AIPIA), Market introduction of active and intelligent packaging by AIPIA members, presentation during ActInPak Conference, 21-23 November 2016, Bled, Slovenia, via Take Home messages, http://www.actinpak.eu/meeting-notes/

[17] Feedback from industry partners during ActInPak conference Status of current developments and challenges in active and intelligent packaging, 4-5 April 2016, Munich, Germany, via Take Home messages, http://www.actinpak.eu/meeting-notes/

[18] Andrew Manly (AIPIA), Market introduction of active and intelligent packaging by AIPIA members, presentation during ActInPak Conference, 21-23 November 2016, Bled, Slovenia, via Take Home messages, http://www.actinpak.eu/meeting-notes/

[19] Industry participants during ActInPak workshop Industry meets Science, 17 November 2015, Utrecht, the Netherlands.

[20] Carol Hammond (Multi Packaging Solutions), "Integration of interactive functionality into high volume carton and label packaging – problems and progress // Market reaction and potential for interactive cartons and labels", presentation during ActInPak conference Existing technologies and current developments in active and intelligent packaging, 15-16 September 2015, Aveiro, Portugal.

[21] Marko Arola (Tempix), Tempix temperature indicator — experiences of market entry, presentation during ActInPak Fair and Conference: Active and Intelligent Packaging on Display, 21 November 2018, Vienna, Austria.

[22] Feedback from industry partners during ActInPak conference Status of current developments and challenges in active and intelligent packaging, 4-5 April 2016, Munich, Germany, via Take Home messages, http://www.actinpak.eu/meeting-notes/

[23] Wikström, F. , Verghese, K. , Auras, R. , Olsson, A. , Williams, H. , Wever, R. , Grönman, K. , Kvalvåg Pettersen, M. , Møller, H. and Soukka, R. (2019), Packaging Strategies That Save Food: A Research Agenda for 2030. Journal of Industrial Ecology. doi:10.1111/jiec.12769

[24] Marko Arola (Tempix), Tempix temperature indicator — experiences of market entry, presentation during ActInPak Fair

and Conference: Active and Intelligent Packaging on Display, 21 November 2018, Vienna, Austria.
[25] Ana Dopico (University of Vigo), The Consumer Perceived Value: Development of a Measurement Scale for package functions, during ActInPak conference Application & Communication, 7-9 November 2017, Tzuba, Israel.
[26] Jan Parobek (Technical University, Zvolen), Final Consumers Attitudes to Active and Intelligent Packaging in Slovakia, during ActInPak conference Application & Communication, 7-9 November 2017, Tzuba, Israel.
[27] Mika Vähä-Nissi (VTT), Feasibility of active and intelligent packaging for local and organic food in Southern Finland, during ActInPak conference Application & Communication, 7-9 November 2017, Tzuba, Israel.
[28] Siv Lindberg (RI.SE), during ActInPak conference Application & Communication, 7-9 November 2017, Tzuba, Israel.
[29] Shira Rosen (Strauss Group), Turning Consumers into Prosumers, during ActInPak conference Application & Communication, 7-9 November 2017, Tzuba, Israel.
[30] Virpi Korhonen (Sense n Insight), Measuring the Consumer Value of Active and Intelligent Packaging, presentation during ActInPak Fair and Conference: Active and Intelligent Packaging on Display, 21 November 2018,Vienna, Austria.
[31] Jori Ringman (CEPI), Active and intelligent? The paper industry looks in the mirror, presentation during ActInPak workshop Latest developments in A&I packaging and Opportunities for communication of ActInPak, 5-6 June 2018, Riga, Latvia, via Take Home messages, http://www.actinpak.eu/meeting-notes/
[32] Feedback from invited experts during ActInPak WG workshop, 28 February 2017, Valencia, Spain
[33] Hélène BOURGADE, Olivier CHARTIER, Elodie CLUZEL, Nicolas HÉMON, Patrice DOLE, François ZUBER, Arnout FISCHER. Les innovations technologiques, leviers de réduction du gaspillage dans le secteur agroalimentaire : enjeux pour les consommateurs et pour les entreprises Annexes [online]. Rapport Pipame, le ministère de l'Agriculture, de l'Agroalimentaire et de la Forêt, le ministère de l'Économie, de l'Industrie et du Numérique, 2014, 254p. Available on http://agriculture.gouv.fr/sites/minagri/files/documents/pdf/Annexes_Pipame_gaspillage_alimentaire_cle01a2b8.pdf
[34] Feedback from invited experts during ActInPak conference Application & Communication, 7-9 November 2017, Tzuba, Israel, via Take Home messages, http://www.actinpak.eu/meeting-notes/
[35] Tiekstra, S., Trends in Smart Packaging: Connected Packaging and Connected People, presentation during Packaging Innovations, 12 April 2018, Utrecht, Netherlands.
[36] Dieline (2018). Unpacking the Future of Brands: The Dieline's 2018 Trend Report, via https://beta.thedieline.com/blog/2018/2/26/unpacking-the-future-of-brands-the-dielines-2018-trend-report
[37] https://www.uusipuu.fi/en/
[38] Carol Hammond (Multi Packaging Solutions), "Integration of interactive functionality into high volume carton and label packaging – problems and progress // Market reaction and potential for interactive cartons and labels", presentation during ActInPak conference Existing technologies and current developments in active and intelligent packaging, 15-16 September 2015, Aveiro, Portugal.
[39] Feedback from industry partners during ActInPak conference Status of current developments and challenges in active and intelligent packaging, 4-5 April 2016, Munich, Germany, via Take Home messages, http://www.actinpak.eu/meeting-notes/
[40] Olga Munroe (The Retail Institute) and Andy Lima (Leeds Beckett University), Active & Intelligent Packaging for future connected consumer, presentation during ActInPak workshop Latest developments in A&I packaging and Opportunities for communication of ActInPak, 5-6 June 2018, Riga, Latvia.