NewInnoNet

The Near-Zero European Waste Innovation Network

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ABBREVIATIONS

ELV	End of Life Vehicles
EOL	End of life
EPR	Extended Producer Responsibility
MCDM	Multi-Criteria Decision Methodology
MS	EU Member States
WFD	Waste Framework Directive
WEEE	Waste of Electric and Electronic Equipment

READING GUIDE

This report describes a draft outline of the setup of a technology roadmap to reach the near-zero waste EU Economy through technological solutions within the described value chains of WEEE – ELV – packaging plastics. A shared vison within the value chain is the goal to achieve within the roadmap making use of technological solutions, and based on bottlenecks already identified within a value chain analysis.

Basis for the development of the roadmap will be the ideas gathered form NEW_InnoNet partners and stakeholders. All ideas are gathered from the stakeholders and checked on the use within a value chain and material.

The pathways described are possible ways forward that will support the implementation of a solution that will have an effect on a defined bottleneck from the NEW_InnoNet value chain analyses, per value chain.[1] So it must be clear that no pathway will stand on itself and therefore the pathways must be looked at as parts of an integral approach to the near-zero waste EU goal. Each pathway will have to create better circumstances for technological solutions to come to life and being embedded within the value chains or material flows.

This outline of the roadmap is an early draft version of a roadmap and so providing a backbone for the roadmap development, but also leaving enough flexibility to adopt the roadmap to the needs of the independent value chains themselves.

[1] NEW_InnoNet (2016a) Report summarising the analysis of the End-of-Life Vehicle chain (www.newinnonet.eu/downloads/D%202.3_RP_Report%20summarising%20the%20analysis%20of%20the%20End-of-Life%20Vehicle%20chain.pdf), NEW_InnoNet (2016b) Report summarising the analysis of the plastic packaging value chain (www.newinnonet.eu/downloads/D%202.4_RP_Report%20summarising%20the%20analysis%20of%20the%20plastic%20packaging%20value%20chain2.pdf), NEW_InnoNet (*forthcoming*) Report summarising the results of the analysis of Electronics value chain.

1. OBJECTIVE AND SCOPE

1.1 Objective

Within WP3 of the H2020 project NEW_InnoNet a shared vision is developed for use in roadmaps of the value chains defined in WP2.[2] The roadmap will include possible pathways to a near-zero waste EU on these defined value chains and materials.

This document will describe possible pathways to reach a shared vision supporting the near-zero-waste EU goal of the NEW_Innonet project . The roadmap will further elaborate on the possible pathways for the WEEE value chain. Focus will be on the description of pathways (technological and non-technological) across this value chain with focus on metals, plastics and minerals.

1.2 Scope

The roadmaps will address technological solutions for a near-zero waste EU economy within the value chains (WEEE – ELV – and packaging) looking at three materials arising from these value chains (metals – plastics and minerals). These roadmaps will address actions needed, and possible timing, for the technological solution to be implemented to contribute to the European near-zero waste targets.

Box 1: Scope WEEE
WEEE is defined into several types of products at their end of life phase. In the original directive (February 2003) there where 10 types of electronic devices defined as WEEE when entering end of life phase.

- Lamps
- Large electronic equipment
- Small electronic equipment
- Screens, and appliances containing screens > 100 cm^2 diameter
- Cooling, heating and de-moisturisation equipment
- Small ICT and communication devices < 50 cm

WEEE is defined as all electronic products that are discarded after use.

[2] See NEW_InnoNet (2016a), NEW_InnoNet (2016b) and NEW_InnoNet (*forthcoming*).

Box 2: Scope ELV
End-of-Life Vehicles are in most cases a valuable waste product, which is managed by a number of end-of-life stakeholders, who are active to capture the residual value. With respect to the highly contributing role of regulations, the ELV Directive is not the starting point – but at more technical level, the composition of the waste product versus recycling and overall environmental performance.

Actions or solutions to be recommended will not have Regulations and Policies as a Strategic Objective. Revision, addition or elimination of regulations might be justifiable preconditions to make Technological, Economical, Coordinative and Societal pathways functional. Those four pillars will be the cornerstones for the Roadmaps and research agenda's developed under the New_InnoNET project.

Box 3: Scope plastic packaging
Post-consumer plastic waste (including industrial, commercial and municipal waste) can be found in six distinctive waste streams:

- Packaging waste,
- Waste from Electrical and Electronic Equipment (WEEE),
- End of Life Vehicles (ELV),
- Building and Construction Waste (B&C),
- Agricultural waste,
- Other plastic waste, which is a broad and non-specific category including all other types of plastic waste that might occur outside of the five aforementioned waste streams.

Within the context of the NEW_InnoNet project and the corresponding value chain analysis, the scope of the plastic waste value chain is defined as plastic packaging waste.

Packaging is defined as any material which is used to contain, protect, handle, deliver and present goods. Packaging waste can arise from a wide range of sources including supermarkets, retail outlets, manufacturing industries, households, hotels, hospitals, restaurants and transport companies. Items like glass bottles, plastic containers, aluminium cans, food wrappers, timber pallets and drums are all classified as packaging.

1.3 Methodology

The method used for this roadmap is based on the Phaal's T-Plan method of Cambridge. The technological nature of this roadmap is the first reason to select this method. In addition, although it is a technological roadmapping method, it suits broader perspectives than technology only.

The actions needed will be categorized into six different actions: Technological; Scientific; Organizational; Economical; Societal and Regulatory

A technology roadmap is a graphical representation of technologies relating products or competencies and the connections that have evolved between them in the course of time[3]. In this case, the roadmap

[3] Moerhle M., Isenmann R. and Phall R.. Technology Roadmapping for Strategy and Innovation. 2013. Berlin.

developed could be classified as roadmapping for key technologies and it will be drafted as a multi-layered time-based chart, bringing together various perspectives into a single visual diagram[4].

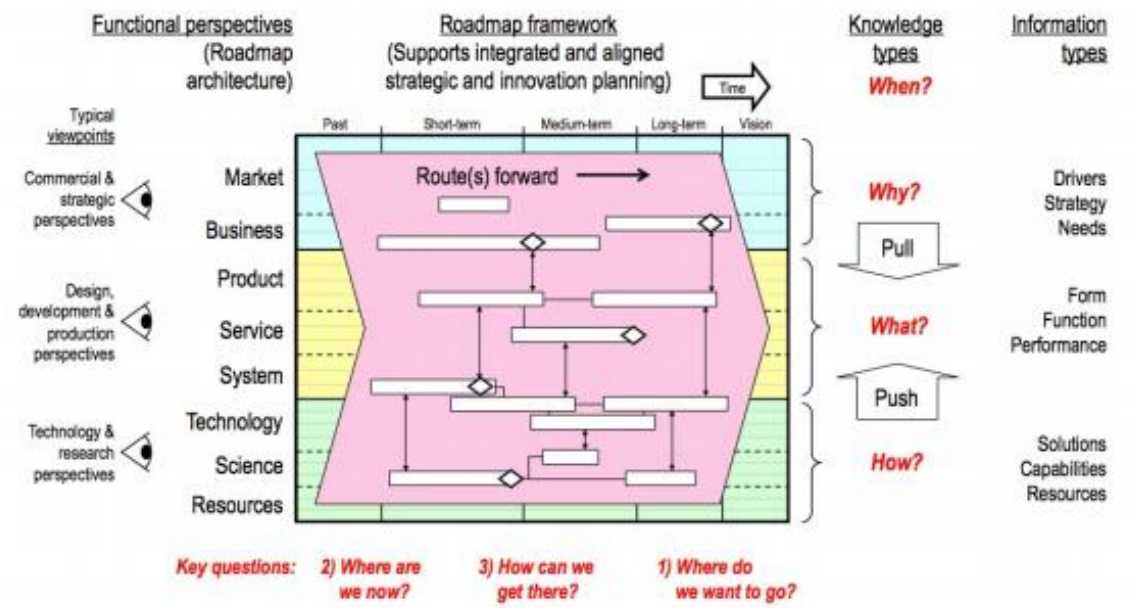

Figure 1 Schematic multi-layered roadmap, aligning multiple perspectives, highlighting fundamental generic strategic questions in red

The method used to come to this roadmap presentation starts with gathering ideas from stakeholders for technological solutions for reaching a near-zero waste EU from 2023 onwards. The gathered ideas are then logged according to their impact on one of the value chains.

With this we will have an idea on how these ideas will support the New_InnoNet goals and also how each of the six action lines could contribute to the implementation of the near-zero waste EU.

[4] R. Phaal, Roadmapping for strategy and innovation, Centre for Technology Management, Institute for Manufacturing, University of Cambridge, 2015.

2. BACKGROUND INFORMATION

Within the EU there are large differences in the development of take-back systems for the three value chains. Reasons for this can be found in:

- Difference in infrastructure of waste management within the EU
- Difference in how products are registered when end-of-live
- Difference in logistical possibilities because of high- or low-density population
- Difference in technological development and innovation environment

Because of these differences it is difficult to set a "best practice" example for collection and/or recycling, based on economic principles. Through implementation and development of EU directives, and local legislation there should be some conformity in the approach of waste from the value chains in the EU and how these are collected and processed.

Because of the differences on implementation of legislation that will drive recycling as a wanted solution for waste instead of landfill or even incineration it is not evident that there can be a "best practice" over the whole of the EU.

From the value chain analyses it has become clear that there several major issues that will have big influences on the development of the near-zero waste value chains. These major bottleneck are described in the NEW_InnoNet value chains analyses.[5]

2.1 Shared Vision

To create a near-zero waste EU within WEEE/ELV/Packplast it is crucial to identify via which instruments this goal can be achieved. When looking at the EU and directives affecting WEEE/ELV/packplast there are defined strategies per value chain:

1. Collection targets
2. Recycling and recovery targets
3. Lesser use of hazardous substances like flame retardants
4. Specific guidelines on recyclers and goals for upcycling

When looking at these strategies and the objective to create a technological roadmap we will focus on solutions for the second strategy. Whereas the other strategies will be of great importance for the actions that should be taken to achieve better recycling and recovery targets.

[5] See NEW_InnoNet (2016a), NEW_InnoNet (2016b) and NEW_InnoNet (forthcoming).

2.2 Technological solutions

Technological solutions are the backbone of this roadmap. There were ideas gathered within the NEW_InnoNet stakeholder community on technological solutions and how they could be implemented. These ideas were collected through the use of an ideation form (Annex 1).

All ideations were gathered and analyzed according to their impact on both the value chains (ELV – Packaging – WEEE) as well as the materials (Metal – Plastic – Mineral). The initial results of this analysis are shown in Table 1.

During the development of the roadmaps, through stakeholder involvement, the number of ideas will rise giving a good overview of technological ideas that are being developed or seen as positive development for the future.

Table 1.

Number	Contact	Title	Value chain			Material		
			ELV	PACK	WEEE	Metal	Plastic	Mineral
1	IVL	Imporved characterisation of sec. plastics	x	x	x		x	
2	ARN	Impact of composites on ELV recycling	x			x	x	x
3	Tecnalia	Use of composites in ELV value chain	x	x	x		x	
4	VITO	Innovative collection system for packaging waste		x			x	
5	IETU	Analysis of input stream in accordance with value	x	x	x	x	x	x
6	VITO	Packaging shape-colour and label recognition		x			x	
7	PNO	Magnetic Density Separation	x	x	x	x	x	x
8	IVL	Better post shredder sorting	x			x		
9	VGG	Non thermal treatment of Rare Earth Metals from electronics			x	x		
10	VGG	Standarisation of connections within electronic components	x		x	x	x	
11	IVL	Information/identification system on valuables in electronics			x	x	x	
12	PNO	Design for increased shelf life for food		x			x	
13	SINTEF	Innovative Rare Earth Oxide Mixtures extraction	x		x	x		
14	IETU	Laser marking of components and materials	x	x	x	x	x	x
15	ARN	Spearation of PVC from plastics (concentrates)	x		x	x	x	
16	IETU	Specialized collection points			x	x	x	x
17	PNO	Enzymatic hydrolyses on MSW		x			x	
18	VGG	Tracer based detection and sorting	x	x	x	x	x	
19	SINTEF	Robotic disassembly	x		x	x	x	x
20	VITO	Advanced sorting technology for fractional plastics and black plastics	x	x	x		x	
21	VGG	Design for future product cyle within fast moving goods			x	x	x	
22	VITO	Diassembly of control units form ELV	x		x	x	x	
23	ARN	Understanding key technical reasons for EL choice	x			x	x	x
			15	11	16	16	20	7

All ideations are also analyzed according to the need for actions on the determined six action lines: Technological – Scientific – Organizational – Societal – Economical – Regulatory in order to see which pathways should be taken in account for the realization of a technological idea. The results of this analysis are shown in table 2.

Box 4: Example for WEEE

There are 16 ideations applicable to WEEE of which 14 need technological action, 10 need scientific action, 9 need organizational action, 2 need societal action, 8 need economical action and 9 will need regulatory action.

Looking at the action lines it is shown that the need for societal actions is not of a big concern at this stage. This is logical because before societal actions can be asked it has to be validated that the anticipated goals will be met through this action.

Table 2.

Number	Contact	Title	Value chain	Action lines					
			WEEE	Technological	Scientific	Organisational	Societal	Economical	Regulatory
1	IVL	Imporved characterisation of sec. plastics	x	x				x	
2	ARN	Impact of composites on ELV recycling		x	x	x		x	x
3	Tecnalia	Use of composites in ELV value chain	x	x	x				
4	VITO	Innovative collection system for packaging waste				x	x		
5	IETU	Analysis of input stream in accordance with value	x	x	x			x	
6	VITO	Packaging shape-colour and label recognition		x	x	x		x	
7	PNO	Magnetic Density Separation	x	x		x			x
8	IVL	Better post shredder sorting		x				x	
9	VGG	Non thermal treatment of Rare Earth Metals from electronics	x	x	x				
10	VGG	Standarisation of connections within electronic components	x	x		x		x	x
11	IVL	Information/identification system on valuables in electronics	x	x		x			x
12	PNO	Design for increased shelf life for food		x	x				x
13	SINTEF	Innovative Rare Earth Oxide Mixtures extraction	x	x	x				
14	IETU	Laser marking of components and materials	x	x	x	x		x	x
15	ARN	Spearation of PVC from plastics (concentrates)	x	x	x			x	x
16	IETU	Specialized collection points	x		x	x			x
17	PNO	Enzymatic hydrolyses on MSW		x	x	x	x	x	x
18	VGG	Tracer based detection and sorting	x	x	x	x	x	x	x
19	SINTEF	Robotic disassembly	x	x	x	x	x	x	x
20	VITO	Advanced sorting technology for fractional plastics and black plastics	x	x	x				
21	VGG	Design for future product cyle within fast moving goods	x	x		x		x	x
22	VITO	Diassembly of control units form ELV	x			x			
23	ARN	Understanding key technical reasons for EL choice		x		x	x	x	
			16	20	14	14	5	13	12

2.3 Pathways

2.3.1 Technological

For technologies to be developed for the NEW_InnoNet goal it is crucial that the focus of the technological pathway is material recovery. The recovered material then must have a use with the highest possible added value based on its technological properties. The re-use of materials is based on the circular economy principles and there is a goal in getting materials in circles with the highest added value. For this we will focus on technological solutions that makes it more possible to reuse materials within circles of a higher added value.

Input needed on:

- What are the main drivers of today's use of recycled materials?
- Are there bottlenecks within material recycling?
- What kind of new technologies are there to enhance quality of recycled materials?
- Which stakeholders within the value chain can contribute to achieving the goal?
- How to create more intrinsic value in the waste?
- Creating "intelligence" within the value chain for recognition of materials?

2.3.2 Scientific

To create a good environment throughout the EU for development of technologies towards the near-zero waste EU it is crucial to have a clear and objective way to validate the possible solutions according to the circumstances within each specific EU country or region.

To make sure that development of technology and processes will take in account the impact on environment and health the current used standards for evaluating the sustainability impact should be reviewed.

Scientific actions could be made towards the implementation of standards for the use of materials in relation to virgin materials. At this moment there is a big focus on CO_2 in a value chain. When we want to come to a near-zero waste, EU standards will be needed that will address this goal in a scientific way and also incorporate the resource dependency of the EU for plastics and special metals, from other global regions.

Besides the EU resource policy based on circular economy thinking it is also needed to address the global political situation. In the past a geographical region had its own local policy regarding resources and development. The influence of one geographical region into another with resources is rapidly increasing with the globalization of companies and business strategies based on influencing global material streams and prices.

Input needed on:

- What are the main drivers of today's LCA methodologies?
- What are commonly used methodologies in the value chain?
- Are there really critical materials from a supply stand of view, and what focus should a new LCA standard have to make sure this is important enough?

2.3.3 Economical

Each pathway should lead into business cases that can stand on its own, without everlasting funding schemes supporting them. This does not mean that there is no funding needed to get the business started. One of the critical aspects in this matter will be volume of material and certainty of procurement of the recovered materials. This will be a challenge throughout the this project because of the different legislations regarding the trade of waste and by-products after separation.

Input needed on:

- Input needed on cooperation per country or region of EU.
- Input needed on legislation and implementation problems within EU.
- Input needed on funding schemes.
- Can we incorporate public parties to create enough volume?
- Can we activate citizens to create volume?
- Is it possible to take End Of Life costs in account as producers, so that there could be a higher incentive for reuse of materials?

2.3.4 Coordination

Another pathway to a near-zero waste EU is to create new business models based on the ownership of the material by the producer. Within the circular economy many of those new business models are already drawn up. But we are only in the starting stage of the roll-out of these models. One reason for that is that procurement models are still working on the basis of a traditional client – supplier relationship. Within the described value chains there are already schemes in place where extended producer responsibility is implemented and working. These schemes focus mostly on making sure that if a product becomes waste it is disposed of correctly and with a certain recycling rate. But to what extent recycling is needed (material – energy or heat) is often not described. New business models should be based on the idea that a certain amount of material should be made into material/component that can be used by the same industry that created the product containing the materials.

Involvement of industry (brand owners) is crucial to create value chains where materials will no longer be excluded from this value chain but will be put back into value chains as a product, component or secondary material. Only the manufacturers are able to really close the circle of a material by implementing secondary materials into products. They also can play a huge role in the business case for dismantling of components by designing for recycling.

Input needed on:

- Current fees for EPR schemes and how these work?
- How this type of design could work for them?
- Ensuring ownership of materials in a global market place (focus on EU).
- Creation of a materials database of products entering the market and the composition.

2.3.5 Legislative

Looking at legislative ways to enhance the recycling rates and re-use of materials there should be looked at ways to incorporate the End-of-Life costs into the design of the product and the origin of materials. When designers will be faced with certain % of recycled material that they are obliged to put into the product they will have a need for stability in their supply chain. Also they will want some understanding of the properties of the materials coming from recyclers to them. Because they know what materials they use in their own products this will be an incentive to make sure that recycled materials come from a specified EOL source. Thus enhancing, from producer side, the need for better sorting en purifying technologies. Which will give way to the development of technological solutions that are now in research and/or pilot phase.

Input needed on:

- How could this work for producers, and could it be fitted into existing schemes?
- What timeframe is needed for such changes in legislations?
- How to coop with global markets for products and the differences in recycling standards per region?

2.3.6 Social

To achieve bigger volumes of material for the value chains it is necessary that citizens are made aware of the impact of a near-zero waste EU and how they can contribute to that goal. It is also evident that there must be some kind of incentive for the citizens to do the work of keeping waste separated at home or make the effort to bring it to the collection points. For some regions in EU this is already established but in some this will be a challenge because of the rural nature of the region.

3. CONCLUSION

To reach the goal of a near-zero waste EU within the three value chains it is clear that there is a good and baseline of operations at this moment. This also means that the bottlenecks remaining are harder to overcome and will have impact on bigger parts of the value chains. Conclusion within the roadmaps will address technological ideas addressing the described bottlenecks and also give an indication on timing and stakeholder involvement needed to achieve the NEW_InnoNet goals.

Gathering of these ideas will be done through input of the NEW_InnoNet partners, input from stakeholder and from NEW_InnoNet partners' networks. To get input from the registered stakeholders of NEW_InnoNet there will be workshops per value chain and follow-up meetings on the development of the roadmap. In addition, draft roadmaps will be available on the NEW_InnoNet website enabling stakeholders to give input on the various steps of the roadmapping process.

LIST OF LITERATURE & REFERENCES

List of literature

NEW_InnoNet (2016a) Report summarising the analysis of the End-of-Life Vehicle chain (www.newinnonet.eu/downloads/D%202.3_RP_Report%20summarising%20the%20analysis%20of%20the%20End-of-Life%20Vehicle%20chain.pdf)

NEW_InnoNet (2016b) Report summarising the analysis of the plastic packaging value chain (www.newinnonet.eu/downloads/D%202.4_RP_Report%20summarising%20the%20analysis%20of%20the%20plastic%20packaging%20value%20chain2.pdf)

NEW_InnoNet (forthcoming) Report summarising the results of the analysis of Electronics value chain.

Moerhle M., Isenmann R. and Phall R.. Technology Roadmapping for Strategy and Innovation. 2013. Berlin.

R. Phaal, Roadmapping for strategy and innovation, Centre for Technology Management, Institute for Manufacturing, University of Cambridge, 2015.

ANNEXES

IDEATION FORM, A SHORT IDENTIFICATION OF TECHNOLOGICAL IDEA

----------PART 1: to be filled in by the idea owner ----------

Contact person (NewInnonet)	
Contact person (idea)	
Contact email	
Contact organisation	

1. Summary

Short idea description + What?	Short text describing the TECHNONOLIGAL idea and how the idea can contribute to the Near zero waste objective.
Purpose + What?	What concern does this idea solve in relation to the Near zero waste objective?
Action lines + How supportive? + Anticipated result on multiple objectives / action lines	Coordination action + objectives: Technical action + objectives: Economic action + objectives: Legal action + objectives: Social action + objectives:
Scope and applicability – *Boundaries in time, geography, technology*	Timing – Geography cross EU – TRL's

----------PART 2: to be filled in by the idea owner ----------

2. Drivers – Bottleneck impact and Business opportunities

Impact (choose; *high, medium, low*)	Resource efficiency	Business opportunities	Quality materials
	high	high	medium
Description *Elaborate the high-rated drivers*	If impact is high, elaborate on the reasons and mechanisms through which the high impact is achieved		

3. Characterization and positioning of the idea

Origin	○ WEEE ○ ELV ○ FMCG
Material	○ Metal ○ Plastic ○ Mineral
Action type/line	○ Technological ○ Scientific ○ Organisational ○ Societal ○ Economical ○ Regulatory
Bottleneck(s) related to the concern / idea	*Which bottlenecks will be affected will be affected by the idea*
Stakeholder definition	Describe type of stakeholder(s) needed for the right evaluation of the idea

4. Project execution

Ideas about timing, timeframe and planning	○ Short description on actions needed to get complete project idea ○ Time needed to create feasibility for the ideation ○ Needed stakeholder involvement