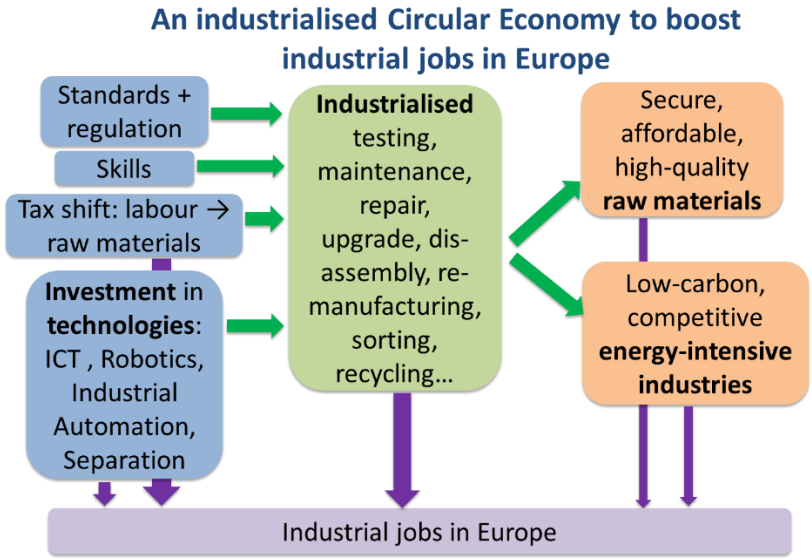
An industrialised Circular Economy

An ambition for industrial trade unions in Europe

The Circular Economy concept means: "closing the loop" of material flows. By feeding the industrial production system with re-used, repaired or upgraded products, or with recycled materials, industrial systems keep the value, materials and energy embedded in industrial products in use far longer. This is a necessity on a planet with finite mineral resources and constitutes a major contribution to the mitigation of climate change. The European Commission published its Circular Economy Package on 2 December 2015. IndustriAll Europe supports the policies outlined in this document but considers that the Circular Economy should be more ambitious. It should be underpinned by industrialised processes in order to be efficient, generate profitable business models, provide affordable and high-quality secondary raw materials and create secure, high-quality industrial jobs in Europe. Achieving this ambition of an "Industrialised Circular Economy" requires a deep transformation of industry, mobilising a broad range of policies and heavy investment in the areas of standardisation, regulation, taxation, skills and innovation. It can be a major opportunity – but the transition must be fair.



Why should European industrial workers reflect on the Circular Economy?

Mineral resources are finite, and the Earth's geology is well-known. No major good surprise is to be expected. Sooner or later, depending on the mineral, cheap and easy mining resources, with high concentrations of mineral in the ore, will be exhausted. This is a physical constraint from which there is no escape.

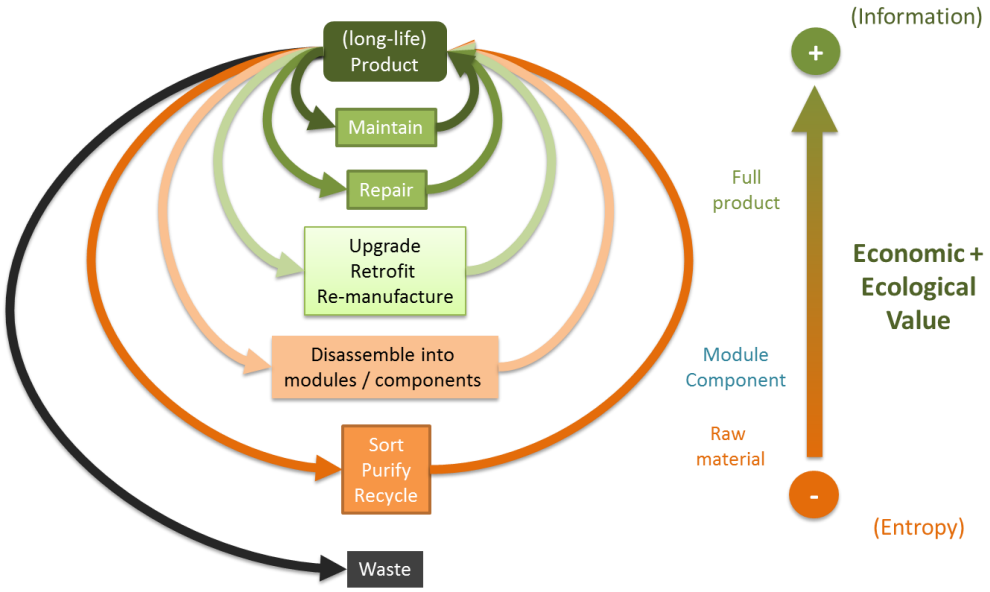
Industry means: transforming matter (and information). Without a material substrate, there is no industry. Industry needs a secure, high-quality and reasonably-priced source of matter to work upon.

Europe is a continent with limited mining resources. It depends upon third countries for its supply. European industries become specifically and increasingly vulnerable to high prices, to market volatility, and to the political situation in supplying countries.

Finally, energy-intensive industries in Europe must cope with increasing energy prices and also participate in the legitimate fight against climate change.

For all these reasons, Europe must act to secure the long-term availability of those raw materials that its industry depends upon. Since the sources of primary raw materials are doomed to end at global scale in the future, in the same way as they have ended in most European mines already, European industry must rely on other sources of matter. The source that is immediately available, and for which there is no supply risk, is the matter contained in existing industrial products present on European soil, i.e. the matter embedded in the installed base of operating industrial goods, or of those that were discarded as waste.

Re-injecting used products or waste back into the industrial production process, while retaining economic and ecological value early in the process, is referred to as the **Circular Economy**. This concept is in contrast to the current "linear" economy where matter flows from the mine to the landfill.



The transition from the current "linear" economy to the future Circular Economy is one of the major political priorities of the current Commission. It was recently stated that the Circular Economy can make a decisive contribution to achieving in 2050 the climate goals of the Paris Agreement[1]. It is thus likely to rise even further in policy prominence. It will be one of the greatest transformations of industry in the 21st century. This transformation has already started in some segments of industry (e.g. the use of scrap metal as a secondary raw material).

Workers in European industry must therefore fully anticipate this change, create the conditions for a fair transition to the Circular Economy and maximise the potential to create industrial jobs in Europe that it promises. Considering that this shift to the Circular Economy is inevitable in the long term, the sooner Europe engages in it, and the earlier these changes

[1] The Finnish public agency for innovation Sitra published a study in June 2018 called "The Circular Economy: a powerful force for climate mitigation". This study states that the contribution of a Circular Economy on an industrial scale (such as described in the present Policy Brief) to the mitigation of climate change is equivalent to the contribution of the whole Energy Union agenda (de-carbonisation of electric power generation and energy-intensive industrial processes). The combination of both policy strands would enable the EU to reach its climate goals, whereas the Energy Union alone would not.

are anticipated for European industrial workers, the better.

The Circular Economy package (December 2015)

On 2 December 2015, the European Commission issued a Communication on the Circular Economy Package[2].

The Commission defines the Circular Economy as one that "*aims to maintain the value of the materials and energy used in products in the value chain for the optimal duration, thus minimising waste and resource use. By preventing losses of value from materials flows, it creates economic opportunities and competitive advantages on a sustainable basis*".

This Communication follows the withdrawal of a previous one (dated 2014), and the adoption of an own-initiative report[3] by the European Parliament in June 2015.

The revised Circular Economy package of 2015 is a very comprehensive work plan, comprising elements on:

- Production
- Consumption
- Waste management
- Market for "secondary" raw materials (i.e. for materials recovered from waste)
- Material-specific measures
- Innovation and
- Indicators.

At the production stage, it plans to modify Eco-design requirements of industrial products so as to include repairability, upgradability, durability and recyclability criteria (in addition to the current requirements regarding energy consumption). It also intends to broaden the scope of the existing Extended Producer Responsibility (EPR) schemes[4]. Finally, it plans to disseminate reference documents describing the Best Available Technology (BAT) for each stage of production.

At the consumption stage, the Commission envisages mandating the display of information regarding the durability and repairability of industrial products. It would also increase the duration of guarantees and sanction false green claims. It promises to engage in research on planned obsolescence so as to confirm or not the current concerns being expressed by the public. It would support Green Public Procurement policies by public authorities in Europe with circular economy criteria.

In the area of waste management, the Commission sets long-term recycling targets and aims at increasing the transparency and efficiency of existing Extended Producer Responsibility schemes. It will also provide technical assistance to Member States and Regions that are the least advanced in waste management and in recycling technologies.

In order to support the uptake of markets for secondary raw materials, the Commission will support the setting of quality standards. It will recognise the validity of organic / waste-based fertilisers. It will ensure the protection of workers against the existence of dangerous chemicals (i.e. those identified as such by the REACH Regulation) in waste flows.

The Commission will undertake measures specific to some categories of materials. For plastics, it will seek to improve their recyclability and bio-degradability and to remove hazardous chemicals. It will also act to reduce marine litter. A specific action plan to recover Critical Raw Materials (i.e. those minerals which are both of high economic value for industry and whose supply is concentrated from politically risky areas) is specified. A better use of biomass and of bio-based resources will be sought. Finally, food,

[2] "Closing the loop - An EU action plan for the Circular Economy" – Communication COM(2015) 614 final

[3] "Report on resource efficiency: moving towards a circular economy" – 2014/2208(INI)

[4] Extended Producer Responsibility is the concept whereby it is the producers' collective duty to recover used items and to recycle them properly.

construction and demolition waste will be minimised.

Regarding innovation and horizontal policies, 650 M€ funding will be made available for innovation in the field of "Industry in Circular Economy". In addition, the concept of "innovation deals" (i.e. an explicit clarification of existing rules by public administration to facilitate innovative ideas, or even the temporary adaptation of the rules to test innovation) will be experimented as a pilot on Circular Economy. Outreach and dissemination actions will be set up to broaden the political support for the Circular Economy.

Finally, indicators will be set up to monitor progress. The Resource Efficiency Scoreboard will be pursued, and a new Raw Materials Scoreboard will be implemented.

IndustriAll Europe generally welcomes this Circular Economy Package by the Commission. It specifically appreciates the encompassing nature of the proposed action plan on the many facets of the Circular Economy. It however regrets that many of the good intentions being expressed are barely translated into concrete action. It also stresses that the intention to increase the recycling rate of industrial products should in no way be a means to re-introduce into material flows the substances that have been banned by the REACH Regulation.

In the view of industriAll Europe, a policy on the Circular Economy could and should be much more ambitious. If the Commission wants to be serious about the Circular Economy, it should understand it as a set of industrial processes. This is the purpose of the concept exposed hereafter.

An ambition for European industrial workers: the concept of Industrialised Circular Economy

While there are examples of efficient and advanced eco-design and recycling industrial units, the processes of the Circular Economy are currently at the margin of the economy and society. The recovery and sorting of materials, as well as the maintenance and repair of most products, are too often performed by hand, by under-qualified workers (sometimes in the framework of the social economy), with inefficient, tinker-grade processes, and under bad working conditions and wages. Workers and firms in these sectors are often trapped in a vicious circle of insufficient investment, inefficient processes and low quality output, and yet costs are too high to compete with primary raw materials at the low selling prices required by the market and resulting low margins. In addition, waste is too often exported further into the margins of our affluent societies, to lesser-developed countries, where it is re-used, recycled or simply dumped under even worse social or environmental conditions.

The concept of an Industrialised Circular Economy is based on the intuition that the only way to simultaneously achieve lower costs and higher quality is to invest more in efficient industrial processes. The ultimate purpose is that almost all processes of the Circular Economy be performed according to well-specified procedures, with extensive support by automated tools and under the control of effective Quality Assurance. This comprises:

- testing,
- maintenance,
- repair,
- re-manufacture,
- upgrade / retrofit,
- dis-assembly,
- sorting and
- recycling.

This industrialisation of processes, their equipment with detailed specifications, automated tools and Quality Assurance, has historically been applied to all the industrial sectors that we know. It is time to extend this transformation to the processes of the Circular Economy. Thereby, the Circular Economy will move from the margins of the economy to its centre. It can be expected to massively generate industrial jobs in Europe (see detailed discussion below).

The tasks of the Circular Economy, currently being performed under difficult wage and working conditions, would thereby be upgraded to full industrial jobs and yet remain accessible to beneficiaries of the social economy.

The exact nature of the actions to be undertaken (in terms of public policy and private investment), and the anticipated effects on the quality and quantity of industrial jobs in Europe, will be detailed hereafter.

The Industrialised Circular Economy is a conceptual model, exposed here in its achieved form for the sake of clarity. Its exact implementation, and the calendar

hereof, will depend on the situation of each industrial value chain and be adapted according to the level of pressure on its supply of primary raw materials.

What investment should be undertaken to achieve the goal of an Industrialised Circular Economy?

The investment necessary to achieve the goal of an industrialised Circular Economy is institutional (creating the rules and standards), technological and cognitive (in skills and competences). It is massive, long and deserves to be started early.

Actions to be undertaken cover:

- **Standards**
- **Regulation**
- **Financial and fiscal incentives**
- **Skills & Training**
- **Innovation**

Standards are needed to define how industrial products can:

- last longer;
- be easy to maintain, test, repair and upgrade (by replacing an obsolete module with a new one, e.g. a more efficient microprocessor);
- be easy to dismantle into recoverable modules or recycle

using efficient, industrial-grade processes, and ensuring that this information is adequately transmitted to the consumer.

Regulation should:

- ensure that standards are actually implemented;
- place a responsibility on manufacturers for product support over long periods of time;
- clarify liability in case of repair or of upgrade between the original manufacturer and the organisation that repaired or upgraded the product;
- create markets for many levels of product usability (new, used, repairable, to be dismantled or waste, and for several levels of waste purity so that every effort to improve this usability or purity be rewarded by a good price.

Financial and fiscal incentives should:

- shift taxes from labour towards the consumption of primary Critical Raw Materials (and potentially to all primary raw materials), so that more jobs be created and less materials used;
- support the business model of the "usage economy", where products are rented or leased instead of being sold;
- make the purchase of longer-life products affordable to all by using well-targeted subsidies.

The provision of **skills** should make sure that:

- all workers are trained and equipped to perform Circular Economy operations in a healthy and safe way;
- the existing competences available in the sectors most advanced in the Circular Economy concept are propagated to all other sectors;
- those workers that are negatively impacted by the transition to a Circular Economy, typically those currently manufacturing short-lived items, should be appropriately and timely up-skilled and trained.

Innovation should bear upon:

- industrial pilots to test, in a complete system setting, the technologies that will be mobilised in an industrialised Circular Economy (e.g. testing, maintenance, dis-assembly, industrial symbiosis, sorting, purification)
- industrial networks and business models, making sure that all players are adequately paid for their work.

These actions are described in further detail in the appendix below.

The general idea of the transition to a Circular Economy is to import in all industrial sectors the design techniques and industrial methods that are already in use in the few sectors that design, manufacture and maintain long-life products (i.e.

products that are repairable, upgradable and recyclable): rail equipment, industrial equipment, construction equipment, defence, aeronautics.

These sectors will provide the competence base for the transition of European industry to a Circular Economy. They happen to be European industrial strongholds. This means two things:

- Europe is well placed to engage successfully in the transition to a Circular Economy because the competence is immediately at hand
- the transition to a Circular Economy can provide the opportunity for European manufacturing to gain a strong competitive advantage.

What costs and benefits in industrial jobs?

The implementation of an industrialised Circular Economy can be expected to have the following effects on industrial jobs in Europe.

It will most probably:

- reduce the number of units being produced in those factories that manufacture large numbers of short-lifetime items (often in the consumer goods industry) and replace them with a lesser number of longer-life items;
- shift activities from some waste management facilities, where operations are currently performed by hand, towards facilities employing more efficient methods;
- increase the activity in the design phase of industrial products in order to achieve higher levels of Quality Assurance and meet stringent Eco-design functional requirements for repairability, maintainability, upgradability and dismantle-ability. Design processes are those in industry which are least vulnerable to the effects of digitalisation and which, within Multinational Corporations, are preferably located in Europe;
- increase activity in industrialised repair, maintenance, upgrade, re-manufacturing and retrofit of industrial products. These processes have a medium vulnerability to digitalisation. They must be geographically close to the customer so that they should also remain located in Europe;
- create a large market for dedicated ICT, software, electronics, robotics and industrial automation;
- create activity in the industrialised disassembly of industrial products;
- create employment because of a tax shift from labour to the usage of primary raw materials;
- ensure the reliable and sustainable supply of high-quality, affordable raw materials for European industry and therefore secure activity;
- lower the carbon footprint of energy-intensive industries because a recycled material already embeds the energy that was used to create it from the primary raw material and is therefore much less carbon-intensive than primary material. This again tends to secure activity for European industries.

Regarding the consequence of the implementation of the Circular Economy that the numbers of short-lifetime consumer items being manufactured will decrease, the following considerations may be made:

- The manufacture of a longer-life, higher-quality item generates more hours worked per unit than that of a shorter-life, low quality item so the decrease in hours worked should be significantly less than that in units produced.
  The manufacture of shorter-life, low quality items has been relocated outside the EU in the recent decades so the impact should be reduced for European industry workers.
- Each assembly factory (often in third countries) requires a symmetrical disassembly factory (on European soil). This is a major factor for re-location of industrial jobs in Europe.

For these three reasons, conversion to the manufacture of high-quality, long-lasting products is susceptible to generate more industrial jobs in Europe than it destroys – even if the number of units being manufactured (and consumed) is smaller.

When considering the impact of an industrialised Circular Economy for each industrial sector, some very preliminary anticipations can be made:

- In the sector of mining, it may reduce activity each year but increase the time during which the mines will be exploited. It may also trigger "urban mining", i.e. the usage of mining technologies (with appropriate safety measures) to exploit landfills as sources of raw materials.
- In the sectors of Basic Metals and Materials (plastics, glass, ceramics, paper, ferrous and non-ferrous metals), it may cause a large shift of workers towards processes handling secondary raw materials. This demands an intense re-training programme.
- In the automotive and home appliances sector, it may cause a shift towards the manufacture of fewer but better-quality items, each of which will demand more working hours of higher qualification. It may also elicit the set-up of dis-assembly factories.
- In the sector of textile, clothing, leather and footwear, it may lead to the manufacture of longer-life products, of better quality and less pressure on price, which could be re-located to Europe.
- In the ship-building and aeronautics sectors, it may elicit the creation of advanced dis-assembly lines with enhanced recovery of modules and equipment.
- In the ICT and mechanical engineering sectors, it may reduce the output of consumer electronics (which mainly takes place outside Europe) and increase that of professional equipment (which is a stronghold of European industry).

Whatever the overall balance, this transition to a Circular Economy must be fair to the workers in those factories manufacturing shorter lifetime products. They must receive the appropriate training and reconversion opportunities on time to adapt to this new industrial paradigm.

In the absence of a complete, quantitative study, it is difficult to draw a balance between all these phenomena although cautious optimism could be possible[5]. An industrialised Circular Economy can therefore be seen as a desirable opportunity for more, better and secure industrial jobs in Europe. IndustriAll Europe will continue its investigations in this direction.

More broadly, an industrialised Circular Economy will stimulate innovation in industrial products and processes. It will improve the well-being of consumers by providing better-quality, long-lasting products. It will also improve the welfare of the citizens of tomorrow by ensuring that they have a sustainable access to the materials necessary for industrial production and to a climate compatible with agriculture and human civilisation.

[5] The "Study on modelling of the economic and environmental impacts of raw material consumption" by Cambridge Econometrics, 2014, anticipates that an improvement in the efficiency of raw materials consumption should have an overall positive impact on employment at EU level, of 1% in 2030, or 2 million jobs, mainly due to the tax shift from labour to raw materials. This overall improvement includes a sharp decline (9%) for employment in non-energy mining. This study is confirmed by several others (GWS, 2011; WEF, 2014).

Appendix: Full description of the policy proposals

For each of these proposals, the following code is used to describe the institutions who are called on to take action:

- [EU] European Union and EU Member States
- [Emp] Employers' and industry associations
- [iAllE] industriAll Europe and its affiliates.

Standards			
• Define Eco-design rules for product longevity, maintainability, repairability, capacity to be dismantled, upgradability and recyclability	[EU]	[Emp]	
• Make information easily available for automated processing	[EU]	[Emp]	
• Provide information to the customer on product longevity, maintainability, upgradability and recyclability	[EU]	[Emp]	[iAllE]
Regulation			
• Mandate the uptake of Circular Economy standards	[EU]		
• Define a minimum period of product support by the manufacturer	[EU]		
• Clarify the liability in case of repair or upgrade / retrofit	[EU]		
• Create an automatic licensing regime for decentralised manufacturing of objects / spare parts	[EU]		
• Create additional legal statuses for the usability of industrial items, between "product" and "waste"	[EU]		
Financial and fiscal incentives			
• Set a tax on primary Critical Raw Materials and relieve tax on labour	[EU]		
• Support the business models of the "usage economy"	[EU]	[Emp]	
• Provide targeted subsidies to support the purchase of longer-life products	[EU]		
Skills and training			
• Train the work force to implement Circular Economy methods and processes in a healthy and safe way	[EU]	[Emp]	[iAllE]
• Propagate existing skills on Circular Economy to the whole industrial sector	[EU]	[Emp]	[iAllE]
• Up-skill and train those workers negatively impacted by the Circular Economy	[EU]	[Emp]	[iAllE]
Innovation			
• Support innovation in industrial pilots	[EU]	[Emp]	

• Support innovation in industrial networking and in business models	[EU]	[Emp]	
Indicators at company, sector and national levels	[EU]	[Emp]	[iAllE]

STANDARDS

Standardise to make information easily available for automated processing

A first difficulty encountered when processing used goods is that the information on them is not immediately available. The description of the mechanical and electric / electronic parts, their specifications, the connections of the electronic board, the functions performed by the software, the operational state of each module and the material composition of the parts, need to be known before any action is undertaken. This information is costly – and long – to acquire when nothing is known beforehand: chemical and physical analysis instruments to enquire about the materials, software retro-engineering, guesses regarding the purpose of components, hand-made trials and errors on dismantling operations, etc. This is a first reason why Circular Economy operations are currently both slow and inefficient.

However, this information has been available in the past history of the item, during its design stage, manufacture, maintenance or upgrade. Keeping track of this information, and recovering it in machine-readable format, is immensely more efficient than attempting to re-construct it *post hoc*. If this information is provided, then the operations of a Circular Economy can be performed efficiently, i.e. with the support of automated industrial tools. However, if this to happen then information must be presented in a standardised way. Thereby, the automated tool can immediately interpret the data and act accordingly, with limited human intervention and with no need to spend precious resources (time or costly instruments) to recover the information from the item itself.

IndustriAll Europe calls for the definition of standards for the industrial processes of the Industrialised Circular Economy. Usage of these standards should be accessible under Fair, Reasonable and Non-Discriminatory (FRAND) conditions so that the value being created by these standards be distributed among all economic actors.

These standards should bear upon:

- interfaces for product and module testing & diagnostic[6];
- the description of maintenance operations and of maintenance levels[7];
- the technical interfaces of modules (including the APIs[8] for software) so as to ease upgrading, modernisation or retrofit of the system[9];
- the description of dismantling operations and of their order of execution;
- the description for re-assembly operations;

[6] E.g.: self-test; measurement of use & wear data such as the number of cycles of an engine; protocol for the exchange of information with the test bed (e.g. the OBD2 standard of the automotive industry); protocol for the remote signalling of failures; protocol for the remote control of the equipment / product under maintenance.

[7] E.g. in 3 levels, such as Level 1: by the user; Level 2: by local repair workshop; Level 3: at the manufacturer's premises – as it is the case for military equipment.

[8] API = Application Programming Interface: the interface of a software module with the external world. The set of instructions that it can interpret, the parameters needed, and the expected outcome.

[9] Upgrade, modernisation or retrofit of a system means: replacing selected modules (including software modules) with others having better performance, while still maintaining compatibility with the rest of the system (and thus being sure that the upgraded system remains operational and safe).

- the instructions to manufacture spare parts (i.e. materials used, 3D-printing programmes, electrical circuit connections);
- the description of material composition[10];
- waste purity levels (e.g. impurity rate <x %) and measurement methods;
- the historical log of all operations performed on the item, during initial production and then during all subsequent maintenance, repair, upgrade / modernisation operations in its product life-cycle;
- the technical means to attach all this standardised information to the industrial good, and the format of this information, e.g. in a "product passport" on an RFID tag or accessible in a remote database via the address stored on an RFID tag;
- the differentiated access rights to the information stored in the "product passport" so as to preserve the confidential information of the original product manufacturer / designer (by restricting access to e.g. authorised maintenance operators only), until this manufacturer / designer relinquishes its responsibility for in-house maintenance and repair;
- the technical means to transmit this data along the product life cycle within the firm (R&D – engineering – design – manufacturing – maintenance – upgrade – recycling), and between firms along the value chain, reliably and securely, as a cross-sectoral application of the Internet of Things (IoT) concept.

In order to keep the purity level of the materials stable even after several recycling cycles, it may be worth considering standardising a finite set of materials for a given range of applications. The materials of this short list would be the only ones permitted for these applications. Other materials (which would be considered as "impurities" when being recycled) would only be allowed in exceptional circumstances and in small quantities, for some specific, demanding applications.

Provide standardised information to the customer on product longevity, maintainability, upgradability & recyclability

IndustriAll Europe supports the proposal by the Commission that the customer (be it a layperson or a professional purchaser) be given the capacity to independently assess the Circular Economy features of an industrial good, using technical standards that define the longevity, maintainability, upgradability and recyclability features of the product and of the industrial system of associated services around it.

These standards should define (1) Eco-design methods, (2) those methods necessary to test materials, components, integrated system products and (3) maintenance / upgrade processes, so that the final product and associated service may be certified and labelled as having a given life duration (including potential maintenance, repair and upgrade operations). All these methods are known in those sectors which are ahead of the race in Circular Economy features (rail equipment, industrial equipment, aeronautics and defence).

The Eco-design rules to enhance repairability, maintainability, upgradability and recyclability include provisions in the design of the product and of the industrial organisation providing the associated services such as:

- all wear pieces and modules are identifiable, separable and easy to replace as regards those containing hazardous substances clearly identified;
- all modules can be separately tested, removed and replaced at all scales (the overall system, the main units, electronic boards, individual components, the firm- and software). The replacement is either

[10] E.g. the existing triangular logo and numbers for the identification of packaging materials (plastics, glass, metal, etc), as defined by the Commission Decision 97/129/EC and the Resin Identification Code of 1988. The degree of detail necessary to fully recover the functional and economic value of each item is however much higher than this coarse taxonomy. This may require further standardisation developments and / or advanced systems including nano-particles in metals, glass or ceramics.

with an equivalent module, or with one having increased performance or functionalities;
- the firm or the sector is organised to perform these maintenance operations over the long term by training its workforce, and preserving its skills and knowledge about older products, and by setting up and maintaining stocks of compatible spare parts.

The methods to measure objectively and to demonstrate the future life duration of a product include: (1) the usage of tested materials, whose long-term behaviour is well-known, (2) the inclusion of life duration computation and of reliability calculations in the design phase, and (3) standardised endurance tests where accelerated ageing of the product is emulated by especially harsh treatment (heat, vibrations, temperature cycles, dust....).

We are aware that consumers might have difficulties in managing the increased complexity of product information. Simplicity and readability of labels are essential for public acceptance. They should be completed by actions to better inform and educate the consumer (e.g. awareness-raising campaigns, at school…).

REGULATION

The uptake of the Circular Economy will not happen spontaneously. More precisely: if we were to wait for market forces alone and for the rise in the price of primary raw materials to trigger the transition to a Circular Economy, it would be far too late, for the following reasons. (1) The investment necessary to equip whole industrial supply chains with the necessary coordination tools (such as standards and regulations) and technologies takes a time that cannot be accelerated (because of the time necessary to reach consensus between all players). (2) The triggering signal would happen at different dates for different raw materials. However, closing the loop of industrial processes must be performed at once for a whole value chain, and cannot be split in a myriad of parallel flows, some of which are linear and others circular. (3) The Circular Economy needs significant investment in material goods (machines, infrastructure). If the price of raw materials has risen (and it can rise to very high levels in short periods of time, in cases of acute shortage of a non-substitutable good or because of speculation), then performing the material investment becomes prohibitively expensive – if possible at all.

For all these reasons, regulation is necessary to accelerate the pace of the transition to the Circular Economy, while we still have the time to coordinate in a peaceful and fair way and still have the necessary primary raw materials in sufficient quantities and at prices low enough to invest in the appropriate equipment and infrastructure.

Mandate the uptake of Circular Economy standards

IndustriAll Europe calls for EU regulation to mandate the use of those Eco-design standards that ensure that products and their associated services last long and are fit for industrialised Circular Economy operations (repair, maintenance, upgrade, dismantle, recycle). We also call for the mandatory display to the customer of the standardised information regarding the product's expected Circular Economy features, such as life duration, failure rate, repairability, maintainability, upgradability, and dismantle-ability, using standardised methods to objectively assess them. A recent study confirms the efficiency of such labels regarding the life duration of products to influence consumer behaviour[11]. The responsibility of the consumer would then be to preferably purchase those products whose life duration and other Circular Economy features are visibly better. These measures are cautiously foreseen by the European Commission in its Circular Economy Package of 2015. IndustriAll Europe encourages the Commission to be much bolder.

Define a minimum period of product support by the manufacturer

In addition to this, industriAll Europe believes that regulation should define, for each category of industrial products sold in Europe, a minimum period

[11] "The Influence of Lifespan Labelling on Consumers", EESC study, March 2016.

of product support, i.e. the time after the sale of the product during which the manufacturer takes responsibility for ensuring its maintenance and upgrade with industrial methods. This minimum period of product support should start at modest values and increase over time.

During the mandatory period of product support, the following items should be maintained operational directly by the manufacturer or under its responsibility:

- a sufficient number of spare parts (e.g. a number covering at least as many years of consumption, including after the end of active production, as the mandatory period of product support), or alternatively the specifications and instructions to manufacture new ones (e.g. via a 3D-printer), including quality assurance test specification;
- the product passport, i.e. the information necessary to test, maintain, repair, upgrade, dismantle and recycle in a safe way the product and its constituents or modules, including software modules (or means to access this information in a database).

During this mandatory period of product support, the original manufacturer should decide and publish how and for how long it intends to fulfil this obligation. It may decide to fulfil this obligation either (1) fully in-house, with the authorisation to keep spare parts and product passport proprietary and confidential, under any format; (2) through a controlled network of accredited service providers, to which it disseminates the spare parts and the product passport, in any format; or (3) to any interested party. The choice between these options could be embedded in the differentiated rights to access the information available on the "product passport". These access rights would then be, respectively: (1) restricted to the company itself; (2) open to the accredited service providers; or (3) open to all.

In the first and second options, the original manufacturer, or its accredited service providers, are in a situation of monopoly regarding the provision of repair and maintenance services. In order to prevent them from abusing this position, the original manufacturer should be mandated to display the price and the anticipated frequency of repair operations on the price tag of the product, in order to enable the customer to make an informed choice.

In the last option, the instructions to manufacture spare parts and the product passport should be made available in a standard format, under a regime of automatic and EU-wide licence, and under Fair, Reasonable and Non-Discriminatory (FRAND) economic and legal conditions.

In addition, the information regarding spare parts and the product passport should also be stored securely with an escrow, in a standardised format, so as to be available to third parties in the event the original manufacturer falls into bankruptcy before the end of the mandatory period of product support.

After the end of this mandatory period of product support, the information regarding spare parts and the product passport should be made freely available to all, in a standard format.

Clarify liability in case of repair or upgrade / retrofit

Under a Circular Economy regime, several legal entities can intervene successively on a given industrial item during its lifetime: the original manufacturer, the firm(s) that repaired i, and those that upgraded / retrofitted it.

This leaves open the issue of liability in case of product failure or an accident. If the Circular Economy is to be taken up, regulation must ensure the same level of industrial guarantees and liability for repaired or upgraded / retrofitted items as for new ones. This should apply also to repairs and upgrades / retrofit operations that involve Free, *Libre* and Open Source (FLOS) software or hardware (such as the output of a 3D-printer).

One way forward could be to enable the publication of the functional specification of industrial parts or products, which would then be open for decentralised replication (e.g. using 3-D printing). This functional specification would include the performance levels necessary for the item to perform its function in the system, and the testing procedures to prove that these performance levels

were attained. The justification of the specification (i.e. the "know why" which allows for building upon the product to develop it further) would not be made public. Under this regime, liability should be rather straightforward: if the (decentralised) manufacturer proves that it has followed the procedure specified by the original designer of the product, then this designer is liable. If not, it is the manufacturer.

IndustriAll Europe calls for a broad, inclusive and EU-wide public policy debate, in each industrial sector, to answer the following questions:

- How should the technical competence and the quality assurance procedures of players in the repair and upgrade / retrofit sectors (which can be individuals) be assessed and certified? What should be the role of Vocational Education and Training in this process?
- What insurance should they subscribe to? Should this insurance be mandatory?
- In what sectors, or for what safety-critical applications should the marketing of modified / upgraded / retrofitted industrial products or software be subject to *ex ante* public authorisation?
- Should there be a threshold of *de minimis* modification / upgrade / retrofit of industrial products or software, under which the safety certification of the original product (and thus its authorisation to be marketed) remains valid? If so, how should this threshold be defined?

Create an automatic licensing regime for decentralised manufacturing of objects / spare parts

When manufacturing of objects or spare parts is decentralised (e.g. when using 3-D printing), the owner of the underlying Intellectual Property (i.e. of the design of the object / spare part) should be paid fairly. On the other hand, this decentralised manufacturing should not be hindered by lengthy licensing discussions.

One way forward could be to set up an EU-wide central repository of IP-protected designs, whose duty would be to manage the IP rights of design owners and obtain payments from the manufacturers, under a uniform licensing regime. Such a repository would function in a mode analogous to agencies currently managing rights for artistic content (e.g. music): any user would automatically be granted a standard license to use the design – but would have to pay the standard royalty to this central repository (which then has the duty to re-distribute these royalties to the design owners).

Create additional legal statuses for the usability of industrial items, between "product" and "waste"

In the current legal regime, there are only two categories of items:

1. **"products",** which can freely circulate and be traded in the Internal Market and to third countries, and for which the price is positive (one pays to obtain the item), or
2. **waste,** for which transport and trade are (legitimately) strongly restricted within the European Union and towards third countries, and for which the price is negative (one pays to get rid of the item).

Already today, and increasingly so under a Circular Economy regime, there exists a range of circumstances in the "grey" zone between these two categories, typically second-hand products. As an example, a significant fraction of the illegal export of waste is performed under the cover of being "second hand products". This uncertainty is compounded by the divergences between the definitions of "waste" between Member States and by the weaknesses and fragmentation of market surveillance authorities in Europe. IndustriAll Europe calls for harmonisation in the definition of "waste" in the EU Internal Market, and for the unification of efforts in the field of market surveillance – specifically to avoid illegal export of waste and of secondary raw materials.

This legal uncertainty is both a loophole through which illegal activities can prosper and a significant barrier to the development of Circular Economy activities. Indeed, the purpose of the Circular Economy is to preserve the value of industrial items (i.e. systems, modules, components, etc.) for as long as possible. This preserved value must translate into

the price of the item so as to generate a profitable business case to recover it and also set up reliable material flows of used items. It must therefore also be acknowledged in its legal status.

In the current situation, the value of the item drops sharply when an item falls from the "product" to "waste" category. In order for the price of the item to decrease in small steps, in line with its preserved usage value, industriAll Europe proposes the creation of a range of intermediate legal statuses for the usability of industrial items.

The following steps could be defined, in decreasing order of usability, for the whole industrial system (e.g. a car) and then recursively for each sub-unit (i.e. for each module / component, e.g. the engine, the on-board computer, the windshield, the tyres):

- new
- second-hand, i.e. fully functional, able to be re-used as is
- repairable by mobilising maintenance skills of level N (N = 1 to 3, see above)
- to be dismantled into sub-units
- to be recycled as raw material, with impurity rate < y% (with the impurity rate taking several steps, e.g. 0.1%, 1%, 5%)
- waste
- hazardous waste.

The precise definition of each category, and the means to test each item so as to determine the category to which it belongs, would be the purpose of appropriate standards (see above).

The usage of these testing standards, performed by certified, independent third parties would be mandatory before an item may claim to belong to any one of these categories, and thus before any transaction is allowed on the market (as is already the case for the second-hand automotive market). The same would apply before any export outside the EU is allowed in order to prevent the illegal export of waste to poor countries.

A market could therefore develop for each usability category of the same item, and the price decrease accordingly.

The rules on the trade and export of industrial items would be dependent on their usability status: full freedom for "new" and "second-hand" items, prohibition for "(hazardous) waste", and increasing restrictions and controls as the usability level of the item decreases.

Specifically, in the case of the export of a "second-hand" product outside the EU, the exporter could be mandated to pay a deposit to the EU customs authority, to be repaid when the product is re-imported back as an item of lesser usability grade to the EU, later in its life cycle.

FINANCIAL & FISCAL INCENTIVES

Incentivise investment in Circular Economy activities, and favour employment with a tax on primary Critical Raw Materials

The most obvious means to enhance the usage of recycled materials and of re-used / re-conditioned or retrofitted equipment in the economy is to reduce the incoming flow of primary material in the production system.

Unfortunately, the usage of recycled materials and of re-used / re-conditioned / retrofitted equipment or modules is currently hampered by the low and highly volatile price of this flow of primary raw materials (and of products that incorporate them). This incoming flow creates severe competition for Circular Economy activities (repair, upgrade, dismantle, recycle).

One means to improve the cost competitiveness of Circular Economy activities is to industrialise them. This is the backbone of the concept presented here.

However, this may be insufficient. Industrialising processes is a long and costly investment, which needs some form of stability in the economic conditions in order to be predictable and profitable.

In order to increase the predictability and the profitability of Circular Economy activities and enhance investment in these industrial installations, industriAll Europe recommends that an internal consumption tax be progressively introduced in the EU on primary Critical Raw Materials and on the primary Critical Raw Material content of industrial items. Critical Raw Materials are defined by the Commission as being both subject to high

geopolitical risk and of high economic value. They are often present in e-waste (from electronics products), of which worldwide production amounted to 41.8 million tons in 2014.

This tax (at a fixed level per kg) would improve the cost competitiveness of Circular Economy activities compared to primary raw materials. It would also create a floor price and thus improve the predictability of investment in the Circular Economy.

This internal consumption tax would be levied on imports and paid back on exports, in a Border Adjustment regime already in place for VAT, fully in line with World Trade Organisation (WTO) rules. This Border Adjustment would fully preserve the external competitiveness of EU basic materials and basic metals industries.

This tax would increase over time, starting at a low leve, so as to engage in a smooth transition. Its proceeds could be used to decrease taxes on labour. This shift in relative costs of raw materials and labour could then favour employment.

In order not to be taxed, a material must be accompanied by a certificate describing its earlier usage, proving that it has indeed been used over several wear cycles (and not just stored in a warehouse waiting for the tax to be lifted).

This reflection must be pursued, in order to avoid unscrupulous operators manipulating the status of "primary" and "used" material or equipment to cheat fiscal and market surveillance authorities and reap illegitimate profits. The sector of waste processing and of materials recycling is unfortunately known for hosting many players of the scene of organised crime, so that specific attention must be given to that point. One way forward could be that the tax should not disappear as soon as a material is no longer considered as "primary": it should decrease slowly over time.

Following the *ex post* assessment of the effectiveness of this tax on the consumption of primary Critical Raw Materials and on employment, this scheme could be extended to other primary raw materials.

Support the business models of the "usage economy"

IndustriAll Europe supports, as a general means to increase the life duration of industrial products, the proposal by the European Commission to progressively increase the duration of the legal guarantee attached to them. IndustriAll Europe also proposes to lengthen the duration of the amortisation of material goods in accounting rules, so as to incentivise maintaining these goods rather than replacing the, and better reflect their remaining value.

In addition to this straightforward measure, we have the following reflections. In the industrial sectors where long-lasting products are the norm (e.g. rail, industrial equipment, aeronautics, defence), the customer (1) has the technical competence to describe its needs, and measure compliance with his requirements, (2) purchases a complete service ensuring full product availability including maintenance and upgrades and (3) has the financial means to perform inter-temporal optimisation and therefore make long-term total cost of ownership a concrete, usable reality.

In order for all industrial sectors to evolve in the direction of products that have Circular Economy features, industriAll Europe believes that it would make sense to re-create for the "normal" consumer the conditions that prevail for professional customers in these more advanced sectors.

The existence and mandatory usage of standards, the implementation of independent certification, the display of labels and adequate information towards the public provide an appropriate surrogate of technical competence. The label incorporates all the technical knowledge of the standard setters and of the certifiers.

Renting or leasing equipment (at a fixed price per time unit), or selling the services that it performs (e.g. per copy for a printer, instead of selling the equipment itself), in the framework of the "usage economy", tends structurally to support longer-life, better maintained products. The rental, leasing or service company, which is the owner of the product, if it is distinct from the manufacturer, has a direct economic interest for these features. In addition, rental, leasing or service companies, when purchasing products, mobilise professional

capacities that enable them to rigorously select those products with the best Circular Economy features.

Another way of looking at this is to consider that the existence of rental, leasing or service firms replaces final consumers with professional purchasers of industrial products – and thus shift the selection criteria from price and brand to intrinsic quality. This shift to purchasing based on quality is a strategic objective of industriAll Europe and should be supported.

IndustriAll Europe therefore recommends supporting the uptake of rental and leasing services for industrial products, whatever the business model chosen (payment per time unit or per unit of service performed), aka “usage economy”, incorporating industrial services such as maintenance, repair, upgrades / retrofit and end-of-life recycling.

The business model of renting or leasing equipment is impeded by two hurdles: (1) the **financial** hurdle of having to finance the whole set of equipment to rent or lease beforehand, and of being paid back over a long period; (2) the **administrative** hurdle of keeping track of the location and status of all equipment being rented out.
In order to open up very broadly the possibility of setting up such rental businesses, the following policies could be implemented:

- creation of a specific status for companies whose only purpose is to own equipment in wholesale volumes for further rental or leasing by retailers to the final user. These "wholesale equipment owners" would rent the equipment at a fixed interest rate in large quantities and for long periods of time to retailers. These retailers would take the risk (and keep the rewards) of renting or leasing the equipment to the final user, with the business model of their choice (payment per time unit or per unit of service performed). Financial investment in "wholesale equipment owners" would qualify as low-risk assets in the balance sheets of banks and other financial institutions (and thus not penalise their solvency ratios) and would be a very good support for the long-term, low-risk asset allocation that pension funds need.
- Development of open-source "inventory management" software and standards so that any retail company renting or leasing equipment to the final user has a low-cost tool to perform all the administrative, maintenance, monitoring, metering and billing tasks needed.

Public procurement could support the uptake of business models of the "usage economy". IndustriAll Europe recommends that the rules for public procurement in the EU be changed so as to incorporate Total Cost of Ownership over the anticipated life time of the product. Guidelines should be provided to public authorities in Europe regarding discount rates, actuarial issues (specifically: on the cost of uncertainty regarding failure rates, in cases when the equipment is in direct ownership instead of being rented or leased) and legal clauses of long-term contracts.

Finally, renting services need to be able to demonstrate the economic value added of what they are offering compared to standard ownership of the product. To do so, they need to have standardised **Life Cycle Costing** procedures. IndustriAll Europe recommends that the Commission should mandate the development of such a standard.

Provide targeted subsidies to support the purchase of longer-life products

Finally, targeted public support may provide the financial means for the purchase of labelled long-lasting products, so that their access is not restricted to the most affluent in society – and also to create the quantitatively broad market necessary to pay back the investments made in the design, testing and certification phase.

IndustriAll Europe recommends that the purchase (or the insurance premiums) of industrial products and attached industrial services (maintenance, repair, upgrade) being certified as “long-life” be publicly supported by targeted subsidies. These subsidies could be reserved for those households with the lesser incomes.

SKILLS & TRAINING

Train the work force to implement Circular Economy methods and processes in a healthy and safe way

First and foremost, it is of uttermost importance that workers dispose of the tools, protection and necessary training to recognise and handle in a safe and appropriate way the hazardous substances and items being present in a flow of used products.

Propagate existing skills on Circular Economy to the whole industrial sector

More generally, the skills, methods and processes for the Circular Economy already exist in some sectors (rail equipment, industrial equipment, aeronautics and defence). IndustriAll Europe recommends that these skills, methods and processes be disseminated broadly to the whole industrial work force.
They include:

- Design rules and methods to achieve Circular Economy features: long duration, repairability, maintainability, ease of disassembly, upgradability, recyclability
- Quality assurance to trace the life-cycle of the product, and be able to intervene at any stage by recovering all contextual information necessary
- High-quality manufacturing for long-lasting products (e.g. precision machining, revertible assembly)
- Industrial processes in maintenance, repair, upgrade and retrofit.

In addition, industriAll Europe recommends that the workers in waste sorting and recycling be trained in the automated testing of industrial products and modules.

Up-skill and train those workers negatively impacted by the Circular Economy

Finally, as some economic activities will probably diminish in size or even disappear with the implementation of the Circular Economy[12], it is of uttermost importance that the workers active in these activities be given a real opportunity to up-skill and adapt.

A huge training and re-training programme is thus required and must be accessible to all workers. It needs to be based on both high-quality training and education opportunities, and real possibilities for workers to participate in them (in particular thanks to time off from work, paid-educational leave, financial compensation for the eventual loss of income, etc.).

Besides a training programme to allow workers to gain the new necessary skills, industry and society need also to recognise those competences that workers already acquired in their current / former occupations that might disappear (cf. supra).

IndustriAll Europe calls for appropriate resources to be dedicated to it, by companies, training centres managed by social partners or other providers, and public education authorities.

INNOVATION

Support innovation in industrial pilots

Setting up the Circular Economy is a major and integrate, transformation of whole industrial supply chains. It requires a complete set of institutional tools (standards, technical and economic regulation and skills development) to support it, as seen above. It also requires very thorough technical developments. Many of these developments are based on existing technologies, mainly ICT[13] ,

[12] E.g. some subsectors of waste management or those factories currently manufacturing large volumes of shorter lifetime products, and whose quantitative output (in units produced) will be reduced.

[13] The reason why Information & Communication Technologies are so essential in the Circular Economy, i.e. in an economy that preserves the value of objects against degradation, is based upon very fundamental reasons rooted in the dual concepts of entropy and information in Physics. Entropy is the scientific concept to describe and measure disorder and degradation. Information is the opposite of entropy and is the source of order. Increasing information, using Information & Communication Technologies, combats the degradation towards entropy.

industrial automation and robotics – but require them to be integrated on a very broad scale.

IndustriAll Europe calls for the set-up of industrial pilots, supported by public-private R&D financing schemes, to explore and test integrated systems in the following fields:

- Inventory management software for rental companies (see above)
- Product passport (with a part being physically attached to the product; e.g. RFID tag, nano-particles, see above)
- Automated test benches
- Industrialised maintenance centres (based on the experience of leading sectors such as aeronautics, defence, rail and mechanical engineering)
- Full reverse-flow industrial system, from the finished products to modules, components and raw materials, including:
    - Dis-assembly factories
    - Sorting facilities and
    - Reverse logistical flows
- Separation technologies (specifically of composite materials), as well as purification and concentration processes
- Industrial symbiosis concepts, where the output of an industrial process is used as an input for the next (e.g. within an industrial park, but also across national boundaries).

A dis-assembly factory is symmetrical to a manufacturing plant – but it functions with a reverse flow of matter, from the finished product to the modules and to the components, in a tree-like structure, from the trunk to branches, twigs and leaves (while a conventional assembly plant has a structure like that of a river, from small streams to a full river).

In order for the dis-assembly plant to function efficiently, an automated test bench should be established at each node of the dis-assembly tree, in order to assess whether the product / module / component should be held intact and stored with a trace of this positive testing for further use (if it is functional), whether it should be repaired, or whether it should be further disassembled into smaller modules / components, and thus sent to the following node of the tree (or recycled to recover raw materials).

This implies that:

- the test benches are highly flexible and can be re-programmed fast (ideally at each new item coming in);
- each component or module is individually identified with a standard tag (e.g. RFID tag);
- the test procedure is described in a standardised way and freely available for download by the test bench, upon recognition of the incoming item.

Such dis-assembly factories would be much more complex and advanced than standard assembly factories, because of the heterogeneity of the incoming flow of products to be dis-assembled. They would mobilise the most flexible and versatile manufacturing technologies, currently used and developed for the customisation of products to the individual wishes of customers – but for a fully different purpose.

In a linear economy, such as the one existing currently, the logistical flows are one-directional: the industrial products flow from the place of production to the place of consumption (or further transformation), and the transport equipment (container ship, rail wagon, lorry) returns empty – which is a loss in efficiency. In a Circular Economy, each direct flow of new (or re-used / retrofitted / repaired) industrial products is matched by a symmetrical reverse logistical flow of used (or defect) ones. The match will of course never be as neat and adapted in time and volume as the general principle might imply: the place where an item is prepared for re-use / dismantled / recycled is not necessarily the factory where it was produced. However, progressing towards a circular logistical system is necessary and also more efficient than the current one-directional system.

Separation, purification and concentration processes for enhanced sustainability are being investigated in the existing SPIRE Public Private Partnership. They can be adapted from those technologies currently mobilised in the mining sector when extracting raw materials from a geological site, but they also need to cope with the great variety of additives being mixed in metals, plastics, glass or ceramics, which often are of great value (e.g. rare earths in the optical fibres of amplifiers or in the magnets of electric engines).

Support innovation in industrial networking and in business models

An industrialised Circular Economy will need to connect businesses and sectors which were hitherto unconnected into a new network of coordinated and cooperative circular value chains, with intense transfers of competence and technologies. These networks will manage the standards and the flows of materials, modules and complete systems in all stages of usability, in both directions. Thereby, each member of the network will fully and efficiently exploit the output from other members as input for its own activity.

Such circular economy networks are new and complex social and economic institutions, mobilising the private sector, the civic sector and the public sector. They will need to be experimented and tested before full deployment.

Innovation in such circular economy networks, as well as in business models (specifically to support the uptake of rental, leasing or service models under the "usage economy" concept, as seen above) will require specific support, beyond that for technological developments. These experiments in developing a new circular economy in Europe call for the full involvement of industrial workers in their design, implementation and evaluation.

Indicators at company, sector and national levels

The transition to the Circular Economy should be a coordinated effort on all scales of the industrial production system.

At the level of the individual firm and of the industrial site, industriAll Europe demands that the achievements in terms of Resource Efficiency be measured and discussed with trade unions.

At sectoral and national levels, industriAll Europe calls for the Resource Efficiency Scoreboard and the new Raw Materials Scoreboard to be included as political targets in the economic governance process of the Euro zone, aka. European Semester.

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