ICT Standardisation supporting Circular Economy

Report of the Study Group Circular Economy - a sub-group of the EU Multi-Stakeholder Platform for ICT Standardisation.

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Executive Summary

The digital transformation is a major pre-requisite for circular economy. ICT standards are key enablers for the digital transformation laying the foundations and providing the basic building blocks. The EU Rolling Plan for ICT Standardisation 2020 already addresses many key issues and kicks off actions for ICT standardisation relevant to accelerating the digital transformation.

The EU Rolling Plan for ICT Standardisation (Rolling Plan) already addresses a number of topics of direct relevance to circular economy, namely in the context of ICT environmental impact, the digital transformation of industry/advanced manufacturing and water management. Moreover, the Rolling Plan provides the base for looking at structural and systemic areas where aspects of circular economy need to be integrated and respective actions in ICT standardisation sharpened or started, for example in areas such as smart cities, eGovernment, and eProcurement.

A specific chapter on Circular Economy should be added to the Rolling Plan 2021.

Many standards bodies have already set up technical committees or working groups for adequately addressing aspects of circular economy; others have started preparatory work, for example in focus groups and in collaborative activities.

A significant number of standardisation activities of key relevance to circular economy are already ongoing in various standards bodies. These are not covered in the Rolling Plan 2020 but - based on this analysis and beyond - should be added and covered to the Rolling Plan 2021. The respective areas include product passport, digital twin, Energy-related products and material efficiency aspects for eco-design, batteries.

Looking at three examples, the digital transformation of Industry, Textile and Leather and Chemistry, has shown that in all these sectors initial work in support of key objectives for circular economy - including standardisation activities - is already under way.

Building on already available and ongoing standardisation activities some urgent needs have been identified to start or accelerate standards development. There are many needs in the field of vocabularies, semantics, ontologies where work needs to start. In the areas of product passport, digital twin and batteries work can build on existing activities by putting a strong focus on the needs of the circular economy. In addition, it is recommended to start work on an open architecture framework for circular economy in order to identify the concrete architecture and infrastructure needs and linkages. Further needs have been identified around assessing the ecological footprint, e.g. with methods and metrics that can be used in green financing.

The Multi-Stakeholder Platform for ICT Standardisation plays a key role in identifying standardisation needs, sharing information about ongoing work and supporting coordination and cooperation amongst standards bodies as well as a close interlock with the European Commission and with the EU Member States.

Recommendations

The following provides a list of recommendations which were derived during the work of the MSP Study-Group on Circular Economy (SGCE). This list is extracted from the main body where they are also set within the context of the respective analyses:

Circular economy to be a regular topic on the agenda of the MSP – thus keeping a close level of interlock between the European Commission, the Member States and all stakeholders in ICT standardisation and facilitating information exchange as well as necessary cooperation, synchronisation between SDOs. Activities evolving from this may include a workshop to exchange in depth about ongoing and available work and promote cooperation.

The European Commission to request and further encourage standardisation activities via the Rolling Plan. A separate chapter addressing the specific standardisation needs and opportunities for supporting policy objectives for circular economy should be included into the Rolling Plan 2021. This chapter should be reviewed once new policy documents have been published by the European Commission in 2021 in order to ensure fast inclusion of possible additional actions and standardisation needs which will reflect and support the dynamics.

The European Commission with the support of the MSP to review the chapters in the Rolling Plan which have relevance to circular economy with the objective to sharpen this relevance and to add specific actions for circular economy respectively. This should increase the focus on circular economy across all Rolling Plan chapters where it makes sense. The analysis provided in this report – including the details listed in Annex I – can be a good basis for this.

SDOs to do a detailed landscaping of the standards that are available or under way to support circular economy objectives.

SDOs to cooperate and start work in the areas of identifiers, vocabularies, semantics, taxonomies, ontologies for circular economy.

SDOs to start activities that support sustainable product policy objectives like eco-design and its applications to key value chains.

SDOs to build on existing work and progress towards adding standardisation activities for circular economy objectives around product passport.

SDOs to cooperate on developing an Open Architecture Framework for product passport and circular economy.

CEN/CENELEC and ETSI to progress their work on energy-related products towards further addressing needs and supporting objectives of circular economy.

SDOs to cooperate on developing use cases for new and emerging technologies like AI and Blockchain in the context of circular economy and to start respective standardisation activities in order to support making these technologies available fast for supporting circular economy.

SDOs to work on metrics and setting criteria for the assessment of the environmental impact of equipment in the context of green financing.

Introduction

Circular Economy (CE) is a top priority of the European Green Deal, which is one of the pillars of the twin transitions. As the term "twin transitions" implies, achieving the objectives of a Circular Economy will go hand-in-hand with the further progressing of the digital transformation.

Circular Economy is described as a systematic approach to the design of processes, products (including services) and business models, enabling sustainable economic growth by managing resources effectively as a result of making the flow of materials more circular and reducing and ultimately eliminating waste. It requires a systemic approach that includes all levels involved - from the collection of raw material to the full circle of use and re-use. The digital transformation in general standards, and in particular ICT standards, are of high relevance as enablers and facilitators for the required technology moves towards interconnecting different layers, both physical and technical, generating data, analysing, providing and using information, and so forth.

The EU Rolling Plan for ICT Standardisation (Rolling Plan) addresses all policy areas where ICT standardisation can provide support for the implementation of policy objectives. Where the European Commission does not see a regulatory need to issue a formal standardisation request. it reaches out to the entire standardisation community proposing concrete actions and thus encouraging standardisation, e.g. for promoting interoperability. The Rolling Plan is developed in a collaborative process between the European Commission and the members of the EU ICT Multi-Stakeholder Platform (MSP), the major advisory group to the European Commission regarding ICT standardisation. It is updated on an annual basis and the progress against the proposed actions is regularly recorded and reviewed within the MSP.

A study-group on circular economy (SGCE) was set up to develop this report consisting of members of the MSP and officials of the European Commission. The group was tasked to

1. Inform what is available and in progress regarding ICT standardisation in support of policy objectives

2. Direct new actions / planning activity

To address these tasks a thorough analysis of the Rolling Plan 2020 was undertaken. The results are summarised below; the full analysis is available as Annex I to this report. Moreover, the SGCE reached out to all MSP members and other relevant organisations and associations for information and input about areas where ICT standardisation needs exist and about relevant ongoing or already available ICT standardisation activities.

This report was conducted during the summer of 2020. It provides a preliminary perspective only. This perspective is based on a thorough analysis of the Rolling Plan 2020 and on some ad hoc research of the ICT standardisation landscape regarding the topic of circular economy. It also includes recommendations for further expanding on this basis.

Analysis has shown that many activities are under way already. Standards bodies are well set up to address the topic; they have technical committees in place already or have started investigating into needs, e.g. with focus groups, studies or so. Cooperation is already taking place to some extent. with joint working groups as well as formal and informal exchange, and new collaborations have been

triggered by this work of the SGCE. There is, moreover, a close interlock between the European Commission, standards bodies and the standardisation community. In particular, the MSP - including the work on the Rolling Plan - encourages and facilitates an active exchange on available and ongoing activities as well as the identification of gaps, needs and requirements.

Circular Economy - focus on policy, economy and society

The Circular Economy is a paradigm that defines an economic system able to regenerate itself and, consequently, products keep their value as long as possible and there is no waste. The entire productive system must be totally "redesigned" with this new paradigm. The most evident and profound transformations are and will be represented by the great reconversions in the Energy, Industrial (Automotive, Engineering, Iron and Steel), Construction, and Agricultural sectors and in the processes with greater consumption and impact on resources and raw materials (e.g. Supply Chains).

Digital technologies have revolutionised the possibilities for generating, storing, accessing and using product-related information. The possibility to tag and identify products, means that such useful information – both static and dynamic - can be linked to individual products, down to the level of the individual components and materials. Both the European Green Deal and the New Circular Economy Action Plan (CEAP) therefore inter alia identify product passports as a way to contribute to an effective product policy, to empower professional users, and consumers to make more sustainable choices.

The European Green Deal notes that *"Digitalisation can also help improve the availability of information on the characteristics of products sold in the EU. For instance, an electronic product passport could provide information on a product's origin, composition, repair and dismantling possibilities, and end of life handling*".

The ICT sector, therefore, plays a key role in supporting the innovation of production processes related to industrial transformation and can make a significant contribution in speeding up and making more effective and economic the epochal "revolution" underway. This is not just about "digitalisation" of processes: a real digital transformation is needed, processes have to be redesigned "thinking digital" and starting from digital since their (re) conception. The "digital by design" principle must be applied systematically and consistently in many sectors, including policy measures and legislation. There will be an unprecedented need of collaboration between traditional sectors and ICT, especially in standardisation activities. Moreover, the fact that European economy is dominated by small-medium-enterprises (SME) needs to be considered where standards can provide a lot of support for a time-saving and trusted uptake of new methods and processes. Beyond the technical implementation, more and more ICT skills will be required in most traditional sector standardisation.

The European Commission Communication "A new Circular Economy Action Plan for a cleaner and more competitive Europe" (COM(2020) 98 final) identifies a number of areas where digital transformation plays a key role in enabling the circular economy - in particular:

- Designing sustainable products: mobilising the potential of digitalisation of product information, including solutions such as digital passports, tagging and watermarks (Chapter 2.1);
- Circularity in production processes: promoting the use of digital technologies for tracking, tracing and mapping of resources (Chapter 2.3);
- Construction and buildings: promoting measures to improve the durability and adaptability of built assets in line with the circular economy principles for buildings design and developing digital logbooks for buildings (Chapter 3.6);
- Driving the transition through research, innovation and the digital transformation: Digital technologies can track the journeys of products, components and materials and make the resulting data securely accessible. The European data space for smart circular applications will provide the architecture and governance system to drive applications and services such as product passports, resource mapping and consumer information (Chapter 6.3).

Further details are also included in the Circular Economy Action Plan published by the European Commission in March 2020 and including a concrete tracking table: https://ec.europa.eu/environment/circular-economy/pdf/implementation_tracking_table.pdf

As part of the twin transitions, circular economy is a key aspect of the renewal of industry by driving green innovation and increasing competitiveness. Effective ways of handling scarcity of resources will help to decrease dependencies. It has the potential of putting industrial development on fundamentally new grounds. the digital transformation is the key prerequisite. It is necessary to have the data available that is required for managing the processes, identifying materials and how to separate and re-use them.

ICT standardisation supporting Circular Economy

Objectives and the role of ICT standardisation

The rethinking of processes, production, development, lifecycle etc. will require significant changes to how things are done today. There are a number of key objectives that will be driving the changes:

Circular design: There will be a number of needs that need to be considered at the design stage. This includes the need for being able to identify and separate materials at some point in time, or to design processes in new ways. Digital tools will help here to improve both products and processes.

Value chain coordination: Objectives in this context may, for example, include reducing transaction costs, enabling reverse logistics, brokerage and collaborative systems, better service information for consumers, product identification and information for repairers and recyclers or smart legal framing of co-operations and data sharing.

More efficient asset use: This may, for example, be triggered through more intensive and optimal use of buildings and products. Digital technologies can enable platforms and tracking for asset sharing or re-use, and for providing products-as-a-service.

More material efficiency: This addresses a wide range of possible fields. It may, for instance, concern input cost reduction through precision farming and manufacturing, data and systems to ensure higher quality of secondary raw materials.

“Virtualisation” to dematerialise products: This addresses the digital transformation at the core, e.g. through streaming of films and music, and development of "digital" or “virtual twins”.

Waste reduction: Again, this may address processes as well as, for instance, more efficient asset use, durability and precision 3D printing.

ICT standards play a critical role in this context. They are of relevance at very different levels. For example standards are relevant for identifying, capturing, collecting and sharing data, classifying the data, providing data formats, transferring data through different infrastructure levels, analysing data, providing it for making use of it. Standards also support tools to work with data as well as tools for design. Standards define methods as well as metrics, e.g for testing and benchmarking. Standards also lay down rules for data governance. And many more areas.

Recommendation: Circular economy to be a regular topic on the agenda of the MSP – thus keeping a close level of interlock between the European Commission, the Member States and all stakeholders in ICT standardisation and facilitating information exchange as well as necessary cooperation, synchronisation between SDOs. Activities evolving from this may include a workshop to exchange in depth about ongoing and available work and promote cooperation.

Relevant available or ongoing activities included in the Rolling Plan 2020

The Circular Economy does not form a chapter of its own in the current Rolling Plan (Rolling Plan 2020) but will be introduced as a chapter of its own for the next version of the Rolling Plan (Rolling Plan 2021). This work of the SGCE has also been preparatory in this respect, identifying requirements for actions to propose and include via such a chapter.

Recommendation: The European Commission to request and further encourage standardisation activities via the Rolling Plan. A separate chapter addressing the specific standardisation needs and opportunities for supporting policy objectives for circular economy should be included into the Rolling Plan 2021. This chapter should be reviewed once new policy documents have been published by the European Commission in 2021 in order to ensure fast inclusion of possible additional actions and standardisation needs which will reflect and support the dynamics.

The SGCE has made a thorough analysis of the information and actions proposed via the Rolling Plan 2020. In general, a large number of topic areas covered in the Rolling Plan and specific actions proposed relate to the digital transformation. This ranges from topic areas with high attention like Cloud or Internet of Things (IoT), addresses issues around security and privacy, but is also true for

many topic areas where the digital transformation can help to reduce waste and - even better - to identify potentials for re-use.

The analysis has shown that there are many actions that are relevant to circular economy, yet not are all are immediately recognisable as such, so some context setting and sharpening of this relation would be important. The analysis provided in this report may help to guide an activity of stressing the relation of current actions to and their relevance for circular economy.

Looking at the different sectors and topic areas that are in the Rolling Plan 2020, the following four groups may be differentiated in order to get a structured overview and build a structured approach for follow-on planning:

- Foundational or horizontal relevance for digitalisation;
- Directly addressing circular economy;
- Structural or systemic relevance to circular economy;
- Separate topic area with no immediate relevance for circular economy.

At a deeper level the concrete actions and the listed ongoing activities were analysed regarding their potential to contribute to objectives and needs around circular economy. The full analysis is provided in Annex I to this document.

Foundational or horizontal relevance for digitalisation

The digital transformation is the prime requisite for circular economy - and it is also the overriding topic in the Rolling Plan. This includes inThe dteroperability, and base connectivity, but also basic IT and communications building blocks for IT infrastructures and processes that are required and will drive interoperability. Without properly addressing this foundational and horizontal level, digitalisation would not progress, and it would not be able to address circular economy.

Base connectivity: The Rolling Plan addresses the level of base connectivity, in particular with **5G (RP2020 chapter 3.1.1)**. Other technologies like wireless LAN or basic internet protocols are widely deployed and used already and taken as given without any need for actions that would have to be triggered by the current Rolling Plan. The ongoing work on 5G includes major work items on energy efficiency in ETSI TC EE. ITU-T Study Group 5 also looks at studying methodologies for evaluating the effects of ICTs on climate change and the circular economy.

Cloud services and data: Another part of basic infrastructure and connectivity are **Cloud and edge computing (RP2020 chapter 3.1.2)**. The respective actions in the Rolling Plan 2020, for instance for improving the interoperability, data protection and portability of cloud services, are clearly also relevant for providing the ability to store and access information in support the circular economy. Major standards are available in ISO/IEC JTC 1 SC38. Similarly, the topic area of **Big data, open data and public sector information (RP2020 chapter 3.1.3)** pushes actions on data formats, meta data records, respective data mappings and defining specific data sets. The actions are partly driven to support the implementation of the INSPIRE Directive and creating an infrastructure for spatial

information to support environmental objectives and policies. In addition, and also in the context of big data, standardisation activities are in progress in ETSI and in IEEE on energy efficient data processing.

Internet of Things: A topic area at the heart of the digital transformation is **Internet of Things (IoT - RP2020 chapter 3.1.4)** where the policy objective of "greater resource efficiency for a more circular economy" is clearly outlined in the Rolling Plan and where all actions requested contribute to driving digitalisation at various levels. The ongoing standardisation work covers multiple levels, most notably including semantic models, ontologies and gateways for exchanging energy related information and work on the digital twin. Major technical committees are ISO/IEC JTC 1 SC41, IEC TC65, oneM2M and ETSI TC M2M.

Security and privacy: Cybersecurity (RP2020 chapter 3.1.5) is fundamental for all ICT systems and has significant relevance also for technologies and services in the context of circular economy. It will be important that technologies that support circular economy do not open the door to security risks of any kind. It is in particular ISO/IEC JTC 1 SC27, CEN/CENELEC JTC 13 and ETSI TC Cyber where cybersecurity standardisation is pursued.

AI, Blockchain and other new technologies: Artificial Intelligence and Blockchain/Distributed Ledger Technologies (**RP2020 chapters 3.3.11 and 3.3.6**) will play a key role for circular economy. There are no specific actions on circular economy in those chapters in the Rolling Plan 2020 yet, so some actions to focus the attention to circular economy should be added. Respective technical committees are in place in ISO/IEC JTC 1 SC42 (Artificial Intelligence); ISO TC307 and CEN/CENELEC JTC 19 (Blockchain and distributed ledger technologies). Also in ETSI ISG PDL (Permissioned Distributed Ledger) is active.

Directly addressing circular economy

Three sectors or topic areas addressed in the Rolling Plan 2020 have direct relevance for circular economy and already address concrete policy objectives as well as standardisation needs:

ICT Environmental impact (RP2020 chapter 3.4.3): While the focus of this topic area is much broader than circular economy, there is very concrete work already going on, inter alia under standardisation request M/462. In CENELEC, for instance, TC 215 is working on resource efficiency of data centres and energy efficient products deployed in data centres.

The IEEE 1680 Electronic Product Environmental Assessment (EPEAT) series addresses assessment methodologies. Based on the IEEE 1680 standards the EPEAT program provides independent verification of manufacturers' claims and the EPEAT online Registry lists sustainable products from a broader range of manufacturers than any comparable ecolabel.

Advanced Manufacturing (RP2020 chapter 3.4.6): Digitalisation of industry plays a key role for circular economy. Gathering information about material and its use throughout the lifecycle of products is key. This is already strongly expressed in the Rolling Plan 2020 which mentions embracing circular economy during digitalising European industry. In particular it asserts that optimisation of manufacturing lifecycle generated by ICT should also "enhance sustainability, the manufacturing lifecycle must prolong the life of durable industrial products in compliance with circular economy objectives. To lower waste and pollution, and use energy in smarter ways, it should take into account

operations such as testing and diagnosis, disassembly/repair/upgrade, and recycling." There are two concrete actions with relevance to circular economy:

> Action 3: Conduct a study to identify and analyse opportunities for revisions of existing standards (communications, M2M) or new standards with a particular view on new production technologies, manufacturing processes including lifecycle operations (circular economy), functional safety issues and skills-deficit reduction.
>
> Action 9: Standards for ensuring long-term traceability of material to enable re-use and recycling.

Regarding the ongoing activities in standardisation, there are some that create the foundations for addressing issues on circular economy, e.g. around product passport. The main technical committee addressing respective standards is IEC TC 65, which has a close linkage to CENELEC, as well. Major ongoing work is the standardisation of the "product lifecycle record" and the "asset administration shell". Important models to be integrated include those described in the standards EN IEC 82045-2, IEC/TS 62771, W3C SOSA and EN IEC 62507. Moreover, CEN/TC 438 'Additive Manufacturing' works on standardising the process of AM, their process chains (hard and software), test procedures, environmental issues, quality parameters, supply agreements, fundamentals and vocabularies.

Water management (RP2020 chapter 3.4.10): Water management has relevance for circular economy throughout. As is outlined in the objectives for water management, "It is preponderant to improve integrated water resource protection and management in man-made or natural environment by addressing integrated water and wastewater management, water reuse, circular economy, water system monitoring and reporting, pollution reduction and prevention, "... the water domain is characterized by a low level of maturity concerning the integration and standardisation of ICT technology,…". All actions that are in the Rolling Plan 2020 address issues around circular economy more or less directly. These actions are about smart water grids, data platforms and workload optimisations, data interoperability as well as measures for citizen awareness.

Ongoing and available standardisation activities include the development of the standard WaterML by the Open Geospacial Consortium (OGC). A relevant activity in ETSI is the SAREF Investigation for Water (DTR/SmartM2M-103547) determining the requirements for an initial semantic model for the Water domain based on a set of use cases and from available existing data models. ITU-T has set up a Focus Group on Smart Water Management (FG-SWM) which, amongst other activities, investigates on the Role of ICT in Water Resource Management. And ISO/TC 282 works on standardisation of water re-use of any kind and for any purpose. These are just some prominent examples from all ongoing activities and listed in the Rolling Plan 2020.

Structural or systemic relevance for circular economy

A number of topic areas addressed in the Rolling Plan 2020 have structural or systemic relevance for circular economy. This means that they provide a structure or describe systems in the broadest sense that provide something like an environment in which to integrate circular economy or where to sharpen the focus on issues concerning circular economy.

One group of such systems may be described as infrastructures around society, living and mobility. The following six areas are prime examples for such systems where awareness about circular economy

needs to be created and respective ICT standardisation activities to support objectives around circular economy need to be identified and actions requested:

- eGovernment (RP2020 chapter 3.2.4);
- Smart Grids and Smart Metering (RP2020 chapter 3.4.1);
- Smart cities / technologies and services for smart and efficient energy use (RP2020 chapter 3.4.2);
- Common Information Sharing Environment (CISE) for the EU maritime domain (RP2020 chapter 3.4.9);
- Intelligent Transport Systems (ITS) (RP2020 chapter 3.4.5);
- Construction - building information modelling (RP2020 chapter 3.4.8).

Some concrete work on circular economy is already ongoing, e.g. in ETSI with the ISG on Operational energy Efficiency for Users (ISG OEU) which has published a specification that defines global KPI modelling for green smart cities. In ITU-T SG5 “Environment, Climate Change and Circular Economy” is working on the topics of climate change, energy efficiency and clean energy and circular economy, including e-waste.

A second group consists of social systems where some focus on the issues around circular economy will help to avoid or reduce waste, increase product lifetime etc. These are as follows:

- eCall (RP2020 chapter 3.2.5);
- Emergency Communications (RP2020 chapter 3.2.3);
- eHealth, healthy living and ageing (RP2020 chapter 3.2.1).

In all of these areas, ICT standards and a focus on circular economy can lead to an optimisation in the use of equipment or material.

The area of e-Procurement – pre- and post award (RP2020 chapter 3.3.1) is about leveraging the influence governments have on the market. In October 2017 the European Commission published 'Public Procurement for a Circular Economy' to support public purchasers to leverage support for a transition to a circular economy. Circular procurement sets out an approach to green public procurement, which pays special attention to "the purchase of works, goods or services that seek to contribute to the closed energy and material loops within supply chains, whilst minimising, and in the best case avoiding, negative environmental impacts and waste creation across the whole life-cycle". It will be important to take up these objectives and identify concrete actions for ICT standardisation with a focus on circular economy. Similarly e-Invoicing (RP2020 chapter 3.3.2) has strong effects in avoiding waste from the very beginning.

Also on a structural and partly systemic level there are the areas of e-Infrastructures for research data and computing intensive science (RP2020 chapter 3.1.8) and Digital skills and e-Learning (RP2020 chapter 3.2.2). These need to include circular economy as a focus.

Recommendation: The European Commission with the support of the MSP to review the chapters in the Rolling Plan which have relevance to circular economy with the objective to sharpen this relevance and to add specific actions for circular economy respectively. This should increase the focus on

circular economy across all Rolling Plan chapters where it makes sense. The analysis provided in this report – including the details listed in Annex I – can be a good basis for this.

Concrete ongoing activities with direct relevance to Circular Economy not covered in Rolling Plan 2020

Standardisation focus on circular economy

The SGCE reached out to standards bodies as well as NGOs, industry and trade associations in order to identify ongoing activities that are not yet captured in the Rolling Plan but that have direct relevance to Circular Economy. This initial collection of inputs has shown that a number of activities on standardisation for circular economy are already in progress or starting.

Annex II to this report provides a detailed overview on technical committee work and other standardisation activities. Examples are:

- CEN-CENELEC Task Group on Circular Economy (TG-CE) in place in addressing standardisation needs;
- CEN/CENELEC JTC 10 – Energy-related products - Material Efficiency Aspects for Ecodesign
- CENELEC TC 59 X WG 23 – Resource efficiency
- ISO/TC 323 Circular economy with a full set of standards under development and in plan;
- ETSI TC EE (Environmental Engineering) has produced TR 103 476 “Circular Economy (CE) in Information and Communication Technology (ICT); Definition of approaches, concepts and metrics” and is producing an EN on “Assessment of material efficiency of ICT network infrastructure goods (circular economy)” in the scope of standardisation request M/543 on Material Efficiency and in close coordination with CEN-CLC/JTC 10.

On the level of standards foundational for the digital transformation, major activities are also in progress to specifically establish the link on how such standards are relevant in the context of circular economy.

Moreover, many organisations have started landscaping activities on circular economy such as UNECE with a broad concept paper or ITU-T with study groups addressing the topic.

Recommendation: SDOs to do a detailed landscaping of the standards that are available or under way to support circular economy objectives. The MSP may facilitate cooperation in this respect including on the work of respective standardisation roadmaps.

The information collected here is exemplary only. It represents information that was collected short term over the weeks in summer 2020 and addresses a number of areas that have high relevance to circular economy but does not claim to be complete at all. Yet this initial and exemplary input already shows that there is strong commitment in standardisation to address the topic of circular economy and that significant work is already under way to lay a strong foundation for future work.

Product Passport

Smart management of materials, components, products, assets and locations in a circular economy requires large amounts of information. Such information is not readily available today to those who could use it and reconstructing it individually ex-post is usually too difficult or too costly, leading not only to huge losses of value for consumers, producers and the entire economy, but also to pollution and waste. A concept of a "product passport" providing all information about material is foreseen by the European Commission as a way to enable reuse and circular economy.

A lot of work is already ongoing that will be foundational for product passport and product lifecycle. Especially in the context of digitalising industry there are key activities under way where either major aspects, e.g. around product design or identification of material, are already addressed or where respective technology requirements addressing circular economy needs may be added.

Such activities in industry and manufacturing are taking place at an international level in IEC TC 65 with the driving force coming from Europe. The major topic is the standardisation of the "product lifecycle record" and the "asset administration shell". Important models to be integrated include those described in the standards EN IEC 82045-2, IEC/TS 62771, W3C SOSA and EN IEC 62507. The life cycle record model must also consistently reflect the separation between type and instance and the various life cycle models introduced in EN IEC 62890 for life cycle management. The structure of the object must be reproduced in a chronologically comprehensible manner, including the various aspects according to EN IEC 81346. All information must be linked to the object and/or its parts. Part of this work in IEC builds on DIN 77005-1 “Life cycle record for technical objects“ which specifies how information on plants and their parts is managed in a structured manner. The life cycle record and the administration shell for Industrie 4.0-components pursue basically the same objectives and share a broad normative basis. The life cycle record is therefore suitable for inclusion in the standardisation work on Industrie 4.0 as a sub-model of the administration shell. A specific sub-model for information about material, possible toxic aspects, etc. is under discussion already.

Other aspects regarding making use of the data of material and product lifecycles takes place in ISO TC 184. This work includes consideration of further relevant ICT process standards like the OASIS standards UBL and ISO STEP and their use for tracking and coordinating re-use over product lifecycles.

Related to product passport and product lifecycle is the standardisation work going on about the digital twin. Again, the industrial and manufacturing sectors are active here in IEC TC 65 (and related European Technical Committee: CLC/TC 65X) and in ISO/IEC JWG21.

Digital Twin

The digital twin will be of foundational importance for realising the product passport and for implementing infrastructures in the context of circular economy. As it is highly unlikely that every single product and every single piece of material will contain all the detailed information about material, toxic material, etc. it will more likely be on the level of the digital twin where detailed information about deconstructing products, separating material etc. will be provided. Processes will be

initiated and operated regarding the deconstruction, separation and preparation of material for re-use via the digital twin.

Relevant standardisation work on the digital twin is under way in IEC TC65 and in ISO TC 184. Coming from ISO TC 184 the following draft standard has recently been released for comments: ISO/ DIS 23247-1 "Automation systems and integration — Digital Twin framework for manufacturing — Part 1: Overview and general principles".

In addition, a good overview is available in form of an IIC paper: "Digital TwinArchitecture and Standards" (available at https://www.iiconsortium.org/news/joi-articles/2019-November-JoI-Digital-Twin-Architecture-and-Standards.pdf).

Energy-related products - Material Efficiency Aspects for Ecodesign

Concrete work has been going on in CEN/CENELEC JTC 10 addressing aspects of re-use and material efficiency of energy-related products. From this technical committee a full list of new standards - EN 4555X - was recently released:

- EN 45552:2020 ‘General method for the assessment of the durability of energy-related products’;
- EN 45553:2020 ‘General method for the assessment of the ability to remanufacture energy-related products’;
- EN 45554:2020 ‘General methods for the assessment of the ability to repair, reuse and upgrade energy-related products’;
- EN 45555:2019 ‘General methods for assessing the recyclability and recoverability of energy-related products’;
- EN 45556:2019 ‘General method for assessing the proportion of reused components in energy-related products’;
- EN 45557:2020 ‘General method for assessing the proportion of recycled material content in energy-related products’;
- EN 45558:2019 ‘General method to declare the use of critical raw materials in energy-related products’;
- EN 45559:2019 ‘Methods for providing information relating to material efficiency aspects of energy-related products’.

Batteries

Batteries form an essential part of everyday life: they are important components of electrical devices that modern society relies upon to function smoothly in areas such as portable ICT devices or transportation. The portability and mobility development relate predominantly to battery performance,

which relies more and more on ICT technologies and next generation systems - playing a critical role for the reliability and efficiency of energy supply. Also, a legislative proposal is planned for autumn 2020 together with a standardisation request.

Work in the field is mainly driven by the IEC, which contribute to ensuring the interoperability and the safe functioning of batteries and hence the devices and machines they power. At the European level, standardisation activities are supported by CLC/SR 35 'Primary cells and batteries' and CLC/TC 21X 'Secondary cells and batteries', which provide standards for cells and batteries related to product, safety, testing and safe application irrespective of the type, application or configuration (hybrid, stand alone, module). The main applications relate to automotive (car, motorcycle, truck), industrial (telecom, uninterrupted power supply, reliable power supply), portable (computer, tool), onboard batteries (aircraft, railway, ship) and energy storage (renewable, on-grid and off-grid). For standardisation of applications, in particular ICT systems, IEC TC 21 cooperates with relevant technical committees: TC 9 (railway), TC 34 (lightning), TC 69 (power/energy transfer systems), TC 82 (photovoltaic energy systems), TC 105 (fuel cells technologies), TC 116 (electric tools), TC 120 (electric energy storage systems) and ISO TC 22 (road vehicles).

The following horizontal standards are available or being developed:

- EN IEC 60086-6:2020 Primary batteries - Part 6: guidance on environmental aspects;
- EN IEC 63115-1 Secondary cells and batteries - Sealed nickel-metal hybrid cells and batteries for use in industrial applications - part 1: Performance;
- prEN IEC 63218 Secondary cells and batteries - Secondary lithium ion, nickel cadmium and nickel metal hybrid cells and batteries for portable applications - guidance on environmental aspects;
- IEC TS 61851-3-7 Electric vehicles conductive power supply systems - particular requirements for EV supply equipment - battery system communication;
- prEN IEC 62933-4-4 Electrical energy storage systems - environmental requirements for BESS using reused batteries in various installations and aspects of life cycles.

For further information on battery and circular economy: https://www.cencenelec.eu/news/publications/Publications/CEN-CENELECCircularEconomyAccess_rev2020-05-V1.pdf

Textile and leather industry

There are ongoing standardisation activities driven by the textile and leather industries at various level. At the foundational level there are, for example, eBIZ TCF: eBusiness for textile, clothing and footwear (with some current focus on traceability and transparency), and Moda-ML: XML B2B standard for the fashion industry. UNECE has launched a project on “Enhancing Traceability and Transparency of Sustainable Value Chains in the Garment and Footwear Sector” (TTST) - with the support of European Commission, DG DEVCO, and in partnership with ITC (International Trade Center). The aim is twofold: define a framework for traceability and offering guidelines for a call for

actions to the stakeholders and to define the equivalent of a Use Profile for Traceability in fashion industry for the UN/CEFACT XML specifications.

The leather value chain together with the textile value chain are engaged in a pioneering exercise led by UNECE & UN CEFACT, and financed by the EU aiming at developing the recommendations and tools for transparency and traceability in the apparel & footwear industry (https://www.unece.org/info/media/news/trade/2019/transparency-in-fashion-unece-mobilizing-industry-and-experts-to-develop-blockchain-traceability-tool-and-policy-framework-under-eu-funded-project/doc.html). This exercise involves the development under the aegis of UN CEFACT of a standard for communicating along value chains relevant information allowing to substantiate claims. This is very relevant for the circular economy, as:

- certain materials are the result of recycling activities: leather is the result of recycling animal hides, residues of the meat sector; "ocean textiles" is the result of recycling water fished PET bottles; Pinatex is the result of recycling pineapple leaves, a residue of the fruit sector; PalmFil is the textile fibre made with a by-product of palm-trees, etc... The connection between the agricultural sector and the fashion sector requires many adjustments, as they are constituted by SMEs;

- the information on the treatments of the fashion materials and components is important when it comes to the end of life of products and theirs recycling (up-cycling or down-cycling).

The work in plan in the leather and textile sectors relies on IT technologies and IT standards in many ways, including

- cloud computing: the leather sector is considering the setting up of a PEF compliant databank for hosting the LCA datasets of leather, its supplies (hides & skins, chemicals, machine processes). This requires hacker-proof technologies and global architectures;

- big data management: better modelling relevant indicators and impact categories (durability);

- semantics, product categories: translating into ICT relevant language "contaminants" voluntarily or accidentally present in consumer products;

- traceability/product passport: further work is necessary for tracking and tracing components to their origin; relate components cut out of a same piece of material;

- transparency: standardising ways for making environmental footprints become understandable by consumers so that they can make informed environmentally sound purchasing choices;

- linking supply & demand for by-products/secondary raw materials.

These objectives will be considered in identified needs for standardisation, e.g. regarding product passport, foundational standards for digitalisation, vocabularies and semantics, etc.

Chemical industry

The European Chemical Agency (ECHA) provides the SCIP database for information on **S**ubstances of **C**oncern **I**n articles as such or in complex objects (**P**roducts) established under the Waste Framework Directive (WFD):

"Companies supplying articles containing substances of very high concern (SVHCs) on the Candidate List in a concentration above 0.1% weight by weight (w/w) on the EU market have to submit information on these articles to ECHA, as from 5 January 2021. The SCIP database ensures that the information on articles containing Candidate List substances is available throughout the whole lifecycle of products and materials, including at the waste stage. The information in the database is then made available to waste operators and consumers." (see https://echa.europa.eu/scip-database).

In addition, ECHA also runs poison centres. They provide IT tools, guidance and necessary support to assist stakeholders with their obligations and work in close cooperation with the European Commission (see https://poisoncentres.echa.europa.eu/en/home).

Identified Standardisation Needs

Increasing the focus - accelerating the standardisation work

The analysis by SGCE brought forth a number of immediate needs for ICT standardisation, often building on the already ongoing work. This chapter presents an initial list of the most relevant topics. It can only be exemplary and does not claim completeness.

A specific chapter in Rolling Plan 2021 on circular economy will focus the attention for the standardisation needs and further accelerate the start of relevant activities. It should also encourage standards bodies to leverage their available processes that are best for getting new work started quickly.

Circular economy should moreover be a regular topic on the agenda of the MSP. In addition, the European Commission can play a key role in bringing standards bodies together in a workshop for exchanging information about the topic and their work programmes and promote cooperation. Cooperation is key to avoid unnecessary duplication of efforts and make best use of scarce resources.

Foundational for circular economy

Identifiers, Vocabularies, Semantics, Taxonomies, Ontologies

The circular economy will need large amounts of information about tangibles, their production, their circulation in the market and their treatment once their end-of-life is reached. There are so many actors involved and there is such a variety, volume and velocity of information that a single monolithic information system, a central database, a portal, will be bound to failure. While being easier in the beginning, such a central system would be overwhelmed within a short amount of time, will consume

lot of energy (against green ICT concepts) and pose challenges under sensitive vs non sensitive information to be collected and for which reasons.

Instead, a distributed framework should give the variety of actors the ability to communicate easily and securely. An actor must be able to easily send and receive data to any other actor in the circular economy, understand it, process it securely and derive legal certainty from it. Such framework must understand the commercial constraints that come with some data to avoid revealing company secrets. Respect for that requirement will be a significant contribution to making such data available in the marketplace, especially for the circular economy. But in order to achieve this, such a framework needs interoperability on many levels: Syntactical and Semantic interoperability are key. Sometimes, even procedural interoperability will be needed.

Already today, technology provides good platforms for data exchange. XML and UTF-8 are such foundational standards. Many data systems use such formats to import or export data. Syntactic interoperability is well advanced. But for the actors to cope with the complexity of a circular economy, there is a need for semantic interoperability and the integration of the new requirements with existing systems. In order for one actor to understand the other, vocabularies are required. Moreover, it is not only necessary to describe the components of the product like a battery but also that a given material is used for the poles. And because of the large number of actors, there will be many people and many SDOs who make vocabularies. That is where ontologies play a role, because they allow us to say that the pole material used on the pole of car battery is the same as the one used on the battery of a forklift.

Identifiers are an ideal entry point into this world of knowledge. GS1 has a long record in product identification while W3C has developed systems to create a web of data. The two communities propose to join forces in order to lay the foundation of an information system for the circular economy that can work with vocabularies and ontologies. The full text of the suggestion is available online (https://www.gs1.eu/news/a-standards-based-knowledge-system-for-the-circular-economy). But the vocabularies and ontologies themselves are expected to be developed by the relevant specific communities. As an example, the development of so called core vocabularies has been organized by the European Commission and made available via Joinup.

It will, moreover, be important to ensure that the standardised terminology of material efficiency standards is used throughout policy actions as well as when transferred to product specific standards. CEN/CLC/JTC 10 (Energy-related products - Material Efficiency Aspects for Ecodesign) can provide a wide range of support to facilitate this and align terms used in European Commission's Green Deal and Circular Economy action plan, with the aim of not repeating/duplicating work and therefore effectively meeting the higher demand for Circular Economy supporting standards in different CEN/CENELEC bodies.

Recommendation: SDOs to cooperate and start work in the areas of identifiers, vocabularies, semantics, taxonomies, ontologies for circular economy.

Product passport

The new Circular Economy Action Plan (CEAP) launches a Sustainable Products Policy Initiative (SPPI) aimed at (inter alia) *"mobilising the potential of digitalisation of product information, including solutions such as digital passports, tagging and watermarks" and announces "a common European*

Dataspace for Smart Circular Applications with data on value chains and product information" which "*will provide the architecture and governance system to drive applications and services such as product passports, resource mapping and consumer information." For production processes it announces "promoting the use of digital technologies for tracking, tracing and mapping of resources", and in relation to construction and buildings "developing digital logbooks for buildings". It states that waste legislation must be made "fit for the circular economy and the digital age"*.

The European Council has also pushed for work in this area, calling for "*the Commission, in cooperation with the Member States and the stakeholders, to continue assessing and to provide information on the feasibility and characteristics of a digital product factsheet, and, based on that assessment, to develop relevant key elements for product categories with a high circularity potential, including product sustainability and circularity criteria and the content of products, taking into account inter alia already available information, all existing instruments and ongoing activities in the EU legislative and voluntary framework"*.

Recommendation: SDOs to start activities that support sustainable product policy objectives like eco-design and its applications to key value chains. The European Commission should request and further encourage respective standardisation activities via the Rolling Plan.

A product passport is a combination of (1) a globally unique product identification, and (2) standards-based data collected by different value chain actors related to this unique identifier. This data may relate to intermediate and final products, taking into account both the characteristics of the product, information pertaining to its value chain and circular data attributes agreed among the parties.

The product passport could contribute to a more sustainable and circular economy in the EU by:

- providing consumers and public procurers with information about the sustainability and circularity of the products/components placed on the EU market helping them to make informed sustainable decisions;
- providing economic operators with standardised relevant technical and sustainability-related information about products/components along the value chain, so as to facilitate them to perform value-retaining operations of the circular economy such as use-optimisation, sharing, develop services maintenance, reuse, repair, refurbishment, recovery of components and materials;
- enabling industry to develop their data ecosystems, create digital twins and be part of the digital transition
- allow those putting the most sustainable and circular products on the market to reap market rewards through the availability of credible and verifiable data
- contributing to establish a "Right to Repair" (through for example access to information on spares and repair instructions), and facilitate product upgrading (including software), remanufacturing, component recovery and reuse, and ultimately recycling
- supporting market surveillance authorities in carrying out their tasks;

- providing the Commission and national authorities with up-to-date information when reviewing legislations and proposing new ones in product-related areas of action;
- supporting a smooth circulation of goods in the Single Market

To fulfil these objectives product passports would need to:

- be applicable to a single unit/product/component, identified by a globally unique identifier;
- include common, basic and cross-sectoral data attributes based on global open standards already in use by manufacturers and retailers like the Global Trade Item Number - GTIN
- include both quantitative and qualitative information;
- host both static (valid for the lifetime of the product) and dynamic data (evolving or accumulating during this lifetime, such as repairs, upgrades, warranty renewals, transactions) and be kept up-to-date;
- contain standardised and machine-readable data (based on open standards);
- be composed of different levels of access on a need-to-know basis, with public information accessible for free;
- include encrypted information where justified (for example on grounds of intellectual property, commercial sensitivity or privacy);
- be verifiable by regulatory and market surveillance authorities and, where relevant, by an independent third-party;
- include a physical link between the product and the product passport, through widely used non-proprietary carriers such as barcodes, QR code, radio frequency identification (RFID), watermarks or other tagging;
- be based on common ontologies and classifications, and agreed protocols.

Pilots and existing examples of digital product passports typically work as follows:

- Every product type to have a unique digital twin;
- The product can be automatically connected to the internet to obtain basic product identity (“birth certificate”) information in a standardised format;
- An address is created similar to a URL (Uniform Resource Locator) for a product. When combined with a data carrier – QR codes, RFID, or Bluetooth tag – the company and/or customer to connect directly to the product and access the product’s unique digital profile;
- Standards and protocols help streamline the delivery of the product information and systems interoperability;
- Most of the information is present in existing systems of companies (no need to create new systems, only to provide links);

- Distributed ledger technologies, including blockchain can enable secure or encrypted decentralised data and an information trail.

Regulatory requirements could be proposed to establish the most important information to be included, and rules on its production, verification, storage, and access – differentiated between potential users of the information whenever relevant and technically feasible. The data relevant to ensuring circularity in each product group would differ and require convening of stakeholders to establish the key data and a governance system to agree necessary protocols. Standards already used by industry will be taken into account.

The CEAP foresees the creation of a common European "Dataspace for Smart Circular Applications" (EDSCA) as part of a broader European strategy on data. The EDSCA would therefore provide the infrastructure (including rules for governance, storage, maintenance, access…) enabling the creation of the product passport.

Standardisation can build on the already ongoing and available work described above. This includes the development of new features in the existing standards, new sub-models, but also the identification of clear needs and gaps.

Recommendation: SDOs to build on existing work and progress towards adding standardisation activities for circular economy objectives around product passport.

Architecture and Infrastructure

Circular economy requires the integration of technologies and information via various levels and both vertically and horizontally, spreading traditional organisational boundaries and covering the entire life-cycle of material. In order to realise the respective connectivity, data flow, analysis etc. several levels of connection and interworking need to be addressed. This can be supported by a clear understanding of what the different technology steps are and how they relate to technology levels and layers.

Experience has shown that such new technology areas are well supported with some open architecture framework that outlines all the layers and steps and provides a reference framework within which detailed technology parts are further developed. Successful examples from the last couple of years are the Smart Grid Reference Architecture (SGRA) and the Reference Architecture Industrie 4.0 (RAMI 4.0).

It is, therefore, recommended that the SDOs develop an Open Architecture Framework for product passport, taking into account the already ongoing work and acting as a focus point for bringing different approaches as well as technology requirements together.

Recommendation: SDOs to cooperate on developing an Open Architecture Framework for product passport and circular economy.

Energy-related products

Building on the work done in CEN/CENELEC JTC 10, the next challenge lies in developing additional details in how to adapt the methods to each type of product. Measuring durability in a washing machine might be different than measuring it for a laptop, for example. Discussions are already ongoing in the CEN-CENELEC technical committee TC59X for adapting the norms from EN 4555X to household appliances. At the same time ETSI is looking into translating the horizontal standards to telecom devices such as laptops and smartphones.

Recommendation: CEN/CENELEC and ETSI to progress their work on energy-related products towards further addressing needs and supporting objectives of circular economy.

New technologies as key enablers

As stated previously, new technologies like AI and Blockchain will play a major role supporting circular economy. AI will have huge potential in the analysis of data and in identifying material and the respective cases for re-use. Blockchain can, for instance, support enhanced transparency on transactions, and provide reliable data provenance on global supply chains. For example the Global Battery Association's pilot on blockchain is an application on battery global supply chain (battery passport). Also Blockchain can incentivize environmental-friendly behaviour with purpose driven tokens. An example for this is the City of Vienna's pilot on 'culture token' to reward greener travel.

Standardisation should consider these technologies and standards may be developed to integrate and leverage these technologies. A first step may be the development of respective use cases:

- Using blockchains for in tracking supply chains throughout the entire food chain cycle. ("from farm to fork");
- Unique Object Identification (UOI) project, which uses blockchain in the real estate sector to connect applications with dynamic and interoperable data during entire life cycles of (parts of) built objects.
- Using immutable data records on distributed ledgers in supply chains to authenticate the original of an input to the final product;
- Providing of spare parts in digital wearables to ensure recycling or origin of food from sustainable sources (labelling);
- The integration of renewable sources of electricity in Europe's smart grids (balancing);
- Certifying carbon emission trading certificates.

Recommendation: SDOs to cooperate on developing use cases for new and emerging technologies like AI and Blockchain in the context of circular economy and to start respective standardisation activities in order to support making these technologies available fast for supporting circular economy.

Green financing

The transition towards a greener and more sustainable economy does not only depend on technology development but needs to include respective decisions, e.g. in procurement and financing. Standards are critical to lay respective foundations so that objective and informed decisions can be taken.

There is a lack of standards defining the metrics and setting criteria for the assessment of the environmental impact of equipment. As identified in the Technical Annex to the European Commission's Taxonomy Report (Financing A Sustainable European Economy):

"The option to adopt a threshold for multi-purpose solutions (e.g. “50% of activity has to be applied to climate change”) has been considered but turned down not to incur behavioural issues (related to the lack of control over the use of the data and analytics by the end user)

- “The mix of NACE codes (telecommunication, software and data processing) is necessary to keep the category open to solutions that will emerge in the future.
- “Exclusive use of data for climate change mitigation purposes is deemed sufficient to prove significant mitigation contribution and avoid application of thresholds.
- “Example: Advanced weather forecasting models tailored to integrating more renewables in electricity generation. Digital technologies, such as machine-learning algorithms, when applied to weather and power plant output data, can increase the accuracy of renewable forecasts to up to 94%, from around 88% across the industry."

Recommendation: SDOs to work on metrics and setting criteria for the assessment of the environmental impact of equipment in the context of green financing.

Luxembourg sets an example with a law that allows for providing specific incentives for companies incorporated in Luxembourg: If a solution falls under circular economy aspects, 20% of the initial investment may be claimed for co-funding by Luxembourg government. (https://meco.gouvernement.lu/en/actualites.gouvernement%2Ben%2Bactualites%2Btoutes_actualites%2Bcommuniques%2B2020%2B07-juillet%2B22-aides-investissements.html)

Annex I - Detailed Analysis of Rolling Plan 2020

Foundational or horizontal relevance for digitalisation

5G (RP2020 chapter 3.1.1):

Positive effects because of the ability to store and access information in support the Circular Economy.

Actions that contribute to Circular Economy: *None*

Ongoing work that has relevance to Circular Economy

> *ETSI is developing standards for energy efficiency and sustainable energy sources for 5G networks, in TC EE (Environmental Engineering). This will be a significant factor in the viability of 5G, both economically and environmentally.*
>
> *ITU-T SG5 is responsible for studying methodologies for evaluating the effects of ICTs on climate change and the circular economy. It has developed a series of nine ITU-T Recommendations, Supplements and Technical Reports related to the environmental aspects of 5G, which cover aspects ranging from innovative energy storage (ITU-T L.1220) (ITU-T L.1221) (ITU-T L.1222), energy efficiency for future 5G systems (ITU-T L.Suppl.36), 5G technology and human exposure to RF and electromagnetic compatibility - EMF (ITU-T K.Suppl.9).*

Cloud and edge computing (RP2020 chapter 3.1.2):

Positive effects because of the ability to store and process information to support the Circular Economy.

Actions that contribute to Circular Economy: *None*

Ongoing work that has relevance to Circular Economy: *None*

Big data, open data and public sector information (RP2020 chapter 3.1.3):

Positive effects because of the ability to store information to support the Circular Economy.

Actions that contribute to Circular Economy: *None*

Ongoing work that has relevance to Circular Economy

> *ETSI's TC ATTM committee has specified a set of KPIs for energy management for data centres (ETSI ES 205 200-2-1). These have been combined into a single global KPI for data centres, called DCEM, by ETSI's ISG on Operational energy Efficiency for Users (OEU), in ETSI GS OEU 001.*
>
> *IEEE has a series of standards projects related to Big Data (mobile health, energy efficient processing, personal agency and privacy) as well as pre-standardisation activities on Big Data and open data: https://ieeesa.io/rp-open-big-data. IEEE P1926.1, IEEE Draft Standard for a Functional Architecture of Distributed Energy Efficient Big Data Processing*

Internet of Things (RP2020 chapter 3.1.4):

The foundational relevance is addressed in the paragraph outlining the role and importance of IoT: "*Standardisation facilitates the interoperability, compatibility, reliability, security and efficiency of operations on a global scale among different technical solutions, stimulating industry innovation and providing greater clarity to technology evolution. Interoperability between IoT networks operated by different companies along the value chain opens up opportunities to address EU policy objectives, e.g. greater resource efficiency for a more circular economy, sustainable and responsible supply chains through transparency and traceability, and others."*

Actions that contribute to Circular Economy:

> *All actions contribute to driving digitalisation and IoT and promote the adoption of the technology in the market place.*

Ongoing work that has relevance to Circular Economy:

> *Standardisation on energy efficiency:*
>
> *CENELEC:*
>
> *CLC/TC 57 'Power systems management and associated information exchange' has notably developed European Standards for data models in power systems (EN IEC 61850-x), Application Program interfaces (EN IEC 61970-x) and Data and Communication security (EN IEC 62351-x).*
>
> *CLC/TC 205 'Home and Building Electronic Systems (HBES)' has started in 2018 to develop a European Standard on IoT Semantic Ontology Model Description (prEN 50090-6-2), which will explain the HBES IoT Model structures, semantically expressing the current HBES Open System solutions, with the goal of improving the semantic information HBES IoT gateways or HBES IoT devices provide.*
>
> *ETSI*
>
> *The new SAREF standard will allow appliances, of any type, make or manufacturer, to exchange energy related information, with any energy management system (at home or in the cloud) for energy management and keeping the user informed.*
>
> *oneM2M*
>
> *oneM2M is a global initiative to ensure the most efficient deployment of Machine-to-Machine (M2M) communications systems and the Internet of Things (IoT) and it includes several SDOs and representatives of different industry sectors. The latest technical specifications can be found on their website* http://www.onem2m.org/technical/latest-drafts .
>
> *W3C*
>
> *W3C has a Working Group and an Interest Group around the Web of Things. The goal of this work is to reduce fragmentation and to increase interoperability between the variety of things used*

e.g. in the context of smart cities. It integrates into the Linked data approach that allows for a seamless integration of things into the needs of semantics within the circular economy.

Cyber Security (RP2020 chapter 3.1.5)

Cybersecurity is fundamental for all ICT systems and has significant relevance also for services in the context of circular economy. It will be important that technologies to support circular economy will not open the door to security risks of any kind.

Actions that contribute to Circular Economy:

ACTION 4 SDOs to investigate requirements for secure protocols for networks of highly constrained devices and heavily constrained protocol interaction (low bandwidth/ultra-short session duration (50ms)/low processing capabilities

Ongoing work that has relevance to Circular Economy

This needs further checking. A number of SDOs including IETF, OASIS, W3C, but also NIST have projects in place which could be of relevance.

Electronic identification and trust services including e-signatures (RP2020 chapter 3.1.6)

This chapter belongs to the key enablers and security area of the RP. Electronic identification and trust services directly support digital transformation that is an enabler of circular economy (concept of twin ecological and digital transitions). The main policy measure is the eIDAS Regulation that is currently under review.

Actions that contribute to Circular Economy:

All actions contribute to support the digital transformation and promote trustworthiness in digital transactions so indirectly support Circular Economy. Standardisation enables interoperability and the availability of interoperable pan European identification means and trust services has a direct impact in reducing waste of paper, travels and resources.

Ongoing work that has relevance to Circular Economy:

The standardisation activities already mentioned in the RP aim to enable interoperability and therefore to create the conditions for the availability of interoperable pan European identification means and trust services has a direct impact in reducing waste of paper, travels and resources.

ePrivacy (RP2020 chapter 3.1.7)

This chapter belongs to the key enablers and security area of the RP. ePrivacy principles shall be taken into account also within digital processes supporting and enabling Circular Economy.

Digital transformation means that all the processes supporting the production of goods and the delivery of services must be think as digital since the beginning, we can say "digital by design", this should facilitate the application of the foundational "privacy by design" principle of ePrivacy.

Actions that contribute to Circular Economy:

While current actions are effective in supporting ePrivacy policies, no specific action on circular economy is needed.

Artificial Intelligence (RP2020 chapter 3.3.11):

AI will be fundamental for circular economy. This is not yet mentioned in the Rolling Plan 2020 but will have to be included into the Rolling Plan 2021.

Direct relevance to circular economy

The following chapters of the Rolling Plan 2020 already have direct relevance to circular economy.

ICT Environmental impact (RP2020 chapter 3.4.3):

Characterisation of relevance for Circular Economy:

Direct effect because of the objective of reducing greenhouse gas emissions, looking at energy management, and energy consumption.

Actions that contribute to Circular Economy:

Action 1: Definition of Global KPIs for Energy Management of Fixed and Mobile access, and Core networks, as per Mandate M/462.

Action 4: Guidelines for the definition of Green Data Services.

Ongoing work that has relevance to Circular Economy

Standardisation request M/462 on efficient energy: Energy and more general resource management in data centres are addressed by a cross-ESO coordination group (Coordination Group Green Data Centres – CG-GDC): ftp://ftp.cencenelec.eu/EN/EuropeanStandardization/HotTopics/ICT/GreenDataCentres/GDC_report_summary.pdf

CEN: EN50523:2009 Household appliances interworking

CENELEC: CLC/TC 215, working on resource efficiency of data centres and energy efficient products deployed in data centres.

ETSI: TC ATTM, TC CABLE, TC EE cooperate on global KPIs for energy management covering ICT sites (e.g. data centres, transmission nodes), mobile broadband access networks, fixed broadband access networks and cable access networks support the deployment of eco-efficient networks and sites and to monitor the energy management of deployed broadband define green sites and networks for all industrial and commercial users

ITU ITU-T SG5 is developing a series of standards aimed at reducing greenhouse gas emissions and energy consumption. Work to set the environmental requirements for 5G (Electromagnetic

compatibility (EMC); Electromagnetic fields (EMF); Energy feeding and efficiency; and Resistibility). Standards that aim to assess the sustainability impacts of ICTs and adapt ICT infrastructure to the effects of climate change within the framework of the Sustainable Development Goals (SDGs)

IEEE: Many IEEE standardisation activities directly contribute to assessing and reducing the environmental impact of ICT, such as IEEE 802.3 Energy Efficient Ethernet, a new "Green ICT" series of projects, and the IEEE 1680 Electronic Product Environmental Assessment (EPEAT) series. Current IEEE 1680 EPEAT projects include IEEE P1680.4, Draft Standard for Environmental Leadership and Corporate Social Responsibility Assessment of Servers and IEEE P1680.6, Draft Standard for Environmental Assessment of Complex Set Top Boxes.

Digitisation of European Industry (Advanced Manufacturing) (RP2020 chapter 3.4.6):

It mentions embracing circular economy during digitalising European industry. In particular it asserts that optimisation of manufacturing lifecycle generated by ICT should also "enhance sustainability, the manufacturing lifecycle must prolong the life of durable industrial products in compliance with circular economy objectives. To lower waste and pollution, and use energy in smarter ways, it should take into account operations such as testing and diagnosis, disassembly/repair/upgrade, and recycling."

Actions that contribute to Circular Economy:

Action 3: Conduct a study to identify and analyse opportunities for revisions of existing standards (communications, M2M) or new standards with a particular view on new production technologies, manufacturing processes including lifecycle operations (circular economy), functional safety issues and skills-deficit reduction.

Action 9: Standards for ensuring long-term traceability of material to enable re-use and recycling.

Ongoing work that has relevance to Circular Economy

CEN/TC 438 'Additive Manufacturing' to standardize the process of AM, their process chains (hard and software), test procedures, environmental issues, quality parameters, supply agreements, fundamentals and vocabularies.

Water Management Digitisation (RP2020 chapter 3.4.10):

Circular economy is already addressed: "It is preponderant to improve integrated water resource protection and management in man- made or natural environment by addressing integrated water and wastewater management, water reuse, circular economy, water system monitoring and reporting, pollution reduction and prevention, ... the water domain is characterized by a low level of maturity concerning the integration and standardisation of ICT technology,… "

Actions that contribute to Circular Economy: *All actions have relevance to circular economy:*

ACTION 1 Guidelines for the definition of Smart Water Grids, powered by IoT technologies and standards, which contributes to decentralised, circular water and information flow. The concept of the Smart Water Grid is expected to be developed in the framework of ICT4Water Cluster running

projects. Many standard organizations like ETSI, CEN/CENELEC, AIOTI, OGC, OpenFog, BVDA are expected to contribute in coordination with the EC.

ACTION 2 Guidelines and collaborative work among key actors (associations, alliances, SDOs, etc.) for the definition of Water Big Data standardisation frameworks, which contributes to implementing smart water best practices and an interoperability framework for smart water services. Special emphasis is made on key aspects of a big data platform such as integration, analytics, visualisation, development, workload optimisation, security and governance. ICT4Water Cluster uses the testbeds established in the scope of the running projects to prove working concepts. There is a need of coordination with other sector programmes supported by EC like environment, communication and content management, humanitarian operations, space etc.

ACTION 3 Selection and integration of the widely accepted technologies in each class among all the range of suitable standards and ontologies ensuring the interoperability at data and communication level as SAREF for example. Standard organisations like ETSI and CEN/CENELEC have to define the framework that allows the producers, providers, stakeholders and end-users to develop the smart water services next decade. The process needs to be in conformance to the policy set by the European Commission.

ACTION 4 Definition of open models and open data through interoperable platforms. The first steps as a policy decision are made by the EC. Then, standard organisations like ETSI have to define the architectures, data models, ontologies, standard interfaces and protocols to allow data sharing, platforms integration and interoperability.

ACTION 5 Incentives for the adoption of Open Data standards, in order to be able to provide information in a transparent and up to date manner. This action is related to the policy of the EC but needs to be developed taking into account the security. Citizen's awareness is an important issue and is related to the developed open data models by standard organisations in

Ongoing work that has relevance to Circular Economy: *All ongoing work that is listed has some relevance.*

Structural or systemic relevance to circular economy

e-Infrastructures for research data and computing intensive science (RP2020 chapter 3.1.8)

It is expected that CE will introduce new data driven science applications. Examples range from the use of data produced by digitalisation of product information and by intensive tracking, tracing and mapping of resources. Use of data for example can support the optimization, also thank to specific sensors, models, etc., of production, recycle, movement of goods and their maintenance.

Actions that contribute to Circular Economy:

There is currently in the RP a single broad action that likely addresses the CE related needs.

Ongoing work that has relevance to Circular Economy:

ITU

Possible reuse of the digital object architecture and the outcome of SG11 that is studying the global problem of combating counterfeiting.

Proposals for new actions derived from the analysis:

Concrete actions on circular economy, can be twofold:

- *emerging from specific CE needs in terms of infrastructure;*
- *specific standards to support CE such as models, protocols, geo data, etc.*

The former should be addressed in future RP versions; the latter should be considered in the specific section of CE in the RP, if it will be created, or – if not - in this section as a set of additional actions

eHealth, healthy living and ageing (RP2020 chapter 3.2.1)

Possibly positive effects of telemedicine in reduction of waste. In addition, Digitisation of Hospitals and medical centres may contribute to optimisation of resources. Better management of supplies chains and life cycle of devices.

Improvement of Management of spare products and stocks. Medical centers generate a lot of waste. Recycling information and circular management of disposals could be included, taking into account contamination of the waste as well.

Actions that contribute to Circular Economy:

None in the Rolling Plan 2020. But actions to be added could be to include life cycle information to medical devices. Product Passport including how to dispose waste, including sanitisation processes when relevant. Also standards for smart management of stocks, including tools for matching demand, supply chain management (including in networks).

Ongoing work that has relevance to Circular Economy:

Ongoing actions for remote medicine will be relevant for CE (indirectly)

Digital skills and e-Learning (RP2020 chapter 3.2.2)

In general, pan-European e-competence frameworks and tools and efficient and interoperable e-learning solutions are indispensable for reducing digital skills shortages, gaps and mismatches.

The new digital transformation policy goals are expected to increase digital skills shortages and create new gaps and mismatches. On the other hand, e-Learning is directly contributing to CE goals by reducing the impact on the environment compared to in presence learning.

Actions that contribute to Circular Economy:

All actions contribute to design and implement CE.

No specific action on circular economy is present, though.

Ongoing work that has relevance to Circular Economy

Standardisation on e-Learning can have direct impact on CE goal

Proposals for new actions derived from the analysis:

Concrete actions on circular economy should address the need of specific standards on CE related new digital skills to be considered in the specific section of CE in the RP, if it will be created, or – if not - in this section as a set of additional actions.

A number of traditional sectors need to include both general and specific digital competences, a new action to investigate a general extension of e-CF in all sectors to manage in a more structured way this shortage of hybrid competences.

Emergency Communications (RP2020 chapter 3.2.3)

Possibly some indirect contribution because of optimisation of emergency resources, which may prevent waste.

Actions that contribute to Circular Economy:

Improving management of emergency calls management will reduce the waste of resources. The same with logistics.

Ongoing work that has relevance to Circular Economy:

Those related to optimisation of resource management

eGovernment (RP2020 chapter 3.2.4)

eGovernment application and services based on standards have the possibility of contributing to the achievement of Circular economy AP objectives. Standards providing for interoperability can provide the basis for eGovernment applications related to the objectives of circular economy, such as location of recycling facilities, rules applicable to different waste disposal/recycling, providing for a cross border services.

Recycling takes place at local level, and citizens, in particular when are in other areas than their home place, may ignore where those recycling points are or the rules applicable to them.

Linkage of eGov applications with IoT or smart cities may also be positive for circular economy objectives.

Exchange of data between administrations may also help setting up a truly waste market, allowing for exchange of information, allowing waste treatment in network way, leading to better circularity or resources.

eGovernment applications may also serve to create more awareness about the benefits of circular economy.

Actions that contribute to Circular Economy:

Current version of the RP does not include any specific actions related to eGovernment. Actions could be envisaged to analyse standardisation needs and gaps in relation to eGovernment services related to circular economy, both G2G and G2C.

ICT standardisation needs requested by Regulation, i.e., Directive on waste of electronic equipment (interoperability) and INSPIRE Directive, including sharing information between administrations.

Build on Private initiatives (smart tagging for consumers to scan the information)

Digitalise the recycling information already available (e.g., bottles) and add additional relevant data.

Standards to allow public platforms to support CE actions (e.g., for exchange of data), ie., Gren Dataspace

Ongoing work that has relevance to Circular Economy:

Work on metadata, data interoperability, vocabularies shaped to include concepts related to circular economy.

eCall (RP2020 chapter 3.2.5)

Recycling of eCall devices and systems should be part of end of life operations of the vehicle. The same applies to predictive/smart maintenance of the eCall system.

Actions that contribute to Circular Economy:

Action 6, in relation to PTI procedures for eCall system, could help to identify failures, maintenance needs of the eCall system within the vehicle, favouring reparation or replacing of some parts instead of full replacement of the system. As part of Right of Repair

Action 4, in relation to migration to further generation, to contribute with mechanisms allowing smart upgrade of the eCall system without needing complete replacement in case of the advent of new technology generation, i.e., of mobile communication systems. Same in Action 10 for 5G.

Action 5, in relation to integration of eCall in shared vehicle platforms (e.g., C-ITS), avoiding multiplication of devices in the vehicles

Ongoing work that has relevance to Circular Economy

Work of CEN TC 278 WG 15 on standards related to the above mentioned actions (e.g., PTI specifications, integration of eCall in shared platforms.

ETSI MSG work and 3GPP in relation to migration of technologies and possibilities to upgrade the communication equipment OTA in case of migration of technologies.

GSMA activities to recycle the SIM/USIM and eUICC after the end of life of the eCall system.

e-Procurement – pre- and post-award (RP2020 chapter 3.3.1)

In October 2017 the European Commission published 'Public Procurement for a Circular Economy' to support public purchasers to leverage support for a transition to a circular economy.

Circular procurement sets out an approach to green public procurement which pays special attention to "the purchase of works, goods or services that seek to contribute to the closed energy and material loops within supply chains, whilst minimising, and in the best case avoiding, negative environmental impacts and waste creation across the whole life-cycle".

Standardisation should support specifically this approach and facilitate the extension of its practices to the private sector.

Actions that contribute to Circular Economy:

> *Current actions are mostly devoted to address issues related to IPR, the standardisation process itself in terms of speed, object (semantic, syntax, code) and link with open source, use of funding to cover also free availability of standards that are considered in terms of access of standards considered as public goods. Also who should develop the standards is challenged while impact on international standardisation is not considered*
>
> *These aspects are expected to have a huge impact on CE standardisation activities*

Ongoing work that has relevance to Circular Economy

> *Ongoing work on CE is missing from this section, it should be investigated if/what already is ongoing.*
>
> *The OASIS Universal Business Language (UBL) defines a common XML library of business document types supporting digitization of the commercial and logistical processes for domestic and international supply chains. Version 2.1 (UBL v2.1), used in several Member States and in OpenPEPPOL, was adopted as ISO/IEC 19845:2015. UBL includes document schemas that support e-Procurement (e-Tendering) processes.*

Proposals for new actions derived from the analysis:

> *Specific actions on real eProcurement technical goals are missing, who should do what.*
>
> *However the solution of the "IPR issue" and related topics put in danger the contribution that standardisation can give to achievement of the policy goals and there is a risk that this extends to CE in general.*
>
> *An action on the Commission to address and solve these issues is of paramount importance to avoid that this become a major obstacle to achievement of other concrete actions.*
>
> *One or more specific actions to support Circular Procurement should be introduced.*
>
> *An action to extend the use of standards to the private sector and an action for SDOs to contribute to product passport in the context of procurement.*

e-Invoicing (RP2020 chapter 3.3.2)

The characterisation of the relevance of eProcurement applies also to eInvoicing. In addition it should be considered that *the European Directive 2014/55/EU obliges central government bodies of the Member States to accept in public procurement electronic invoices in accordance with EN 16931-1 from 18 April 2019 onwards and local authorities from the 18 April 2020. This standard was developed to support also B2B and it is available free of charge thanks to an agreement between CEN and the Commission.*

Actions that contribute to Circular Economy:

> *Actions promoting use of automatically processable electronic invoicing also contribute to Circular Economy (reduction of paper waste, impact of physical delivery, archives).*

Proposals for new actions derived from the analysis:

> *Specific purposes sector specific extensions for industry to accommodate specific needs is an already foreseen action, it should take into account CE specific requirements, including those needed in relation to fiscal measures introducing specific incentives and disincentives that can be introduced to promote CE.*
>
> *SDOs to contribute to product passport standardization and its use in this context.*

Blockchain and distributed ledger technologies (RP2020 chapter 3.3.6):

Blockchain has great potential in providing an infrastructure for trusted, decentralised and disintermediated services and standardisation is key to support harmonisation, interoperability, transparency, accessibility, monitoring, trustworthiness and governance.

It has great potential in supply chain management, traceability along the supply chains in industry and agri-products.

Actions that contribute to Circular Economy:

> *An update on the white paper on the EU perspective on blockchain/DLT standardisation*

Ongoing work that has relevance to Circular Economy

> *The ongoing update of the white paper on the EU perspective on blockchain/DLT standardisation and the analysis of the standardisation when focusing specifically on circular economy support.*
>
> *Analyse possible Blockchain/DLT standardisation needs and reflect on best way to achieve them.*
>
> *Identify use cases that are relevant for EU policy objectives*

Smart Grids and Smart Metering (RP2020 chapter 3.4.1):

Positive effect because of the objective of increasing energy efficiency and renewable sources, and meeting EU's Energy climate targets of 2030 and 2050 of reducing greenhouse gas emissions

Actions that contribute to Circular Economy:

> *Most of section B discusses interoperability and data exchanges, which itself are not directly associated with circular economy. However, putting these actions in the context of reducing greenhouse gas emissions and increasing renewable resources contributes to circular economy.*

Smart cities / technologies and services for smart and efficient energy use (RP2020 chapter 3.4.2):

Positive effect because of the objective of increasing energy efficiency and renewable sources.

Actions that contribute to Circular Economy:

> *Action 3: Standards for the delivery of parcels and packages discuss optimisation of packages deliveries, which leads to reduction of pollution (less trucks/day) and reduction of energy consumption.*

Ongoing work that has relevance to Circular Economy:

> *EN/TC 465 'Sustainable and Smart Cities and Communities'*
>
> The Coordination Group on Smart and Sustainable Cities and Communities: http://www.cencenelec.eu/standards/Sectors/SmartLiving/smartcities/Pages/SSCC-CG.aspx
>
> ETSI's ISG on Operational energy Efficiency for Users (ISG OEU) has published a specification which defines global KPI modelling for green smart cities.
>
> TU-T SG20 "IoT and smart cities and communities" is working on a draft Recommendation on Framework of smart greenhouse service (Y.ISG-fr): https://itu.int/go/tsg20
>
> ITU-T SG5 "Environment, Climate Change and Circular Economy" is the lead Study Group on ICTs related to the environment, climate change, energy efficiency and clean energy and circular economy, including e-waste.) https://itu.int/go/sg5
>
> EUROCITIES and GREEN DIGITAL CHARTER (GDC): UROCITIES works with its member-cities for "Data" and "Standards & Interoperability" through the two respective working groups of its Knowledge Society Forum, a networking and collaboration mechanism for more than 70 European cities. http://www.greendigitalcharter.eu

Common Information Sharing Environment (CISE) for the EU maritime domain (RP2020 chapter 3.4.9):

Positive effects because common information sharing environment leads to reduction of required resources and increase of efficiency in maritime operations.

Actions that contribute to Circular Economy:

> *Both actions are targeted towards data exchanges and interoperability*

Ongoing work that has relevance to Circular Economy:

> ISO/TC 8: Ships' Energy Efficiency, EEOI, reductions in emissions from ships in freight transport
>
> ONEM2M: retrieval and analysis data in complex systems (Collection and exposure of data form different sources)

ETSI: ETSI ISG CDM: to develop a consistent set of technical specifications to allow data exchange among different legacy systems in a cooperative network

Intelligent Transport Systems (ITS) (RP2020 chapter 3.4.5):

There is no direct relevance of ITS to circular economy included in the Rolling Plan 2020. However, there are a number of use cases that need to be addressed. For the Rolling Plan 2021 the aspects regarding circular economy should be added. Moreover, there are similarities with several tasks addressed and therefore there may be standards that could be re-used in the context of circular economy, e.g. in the area of security and privacy or in the area of dealing with the digital twin.

Actions that contribute to Circular Economy: *None*

Ongoing work that has relevance to Circular Economy. *None*

Construction – building information modelling (RP2020 chapter 3.4.8):

The construction sector is relevant for the EU economy, contributing to 9% of the EU GDP, and is also a horizontal sector, serving many industries: the sector is a major consumer of intermediate products (raw materials, chemicals, electric equipment, etc.) and services (including banking) so has the potential to be one of the key drivers for the circular transformation of the EU economy. the digital transformation of the construction sector is a potential game changer for sustainable development and the EU Strategy. The introduction of building information modelling (BIM) is seen as the main solution to the management of information, especially during the following phases of the asset life cycle: procurement; design; construction (including assembly) and operation.

Actions that contribute to Circular Economy:

standardisation of BIM is key for a sustainable construction sector, to support circular procurement in the construction sector.

Ongoing work that has relevance to Circular Economy

Ongoing work especially in CEN/TC442 and ISO/TC59/SC13 for BIM development and harmonization of open data formats, structures and classification systems for model based working in the construction industry. Development of common information requirements for project and information management as part of construction service procurement standards.

Annex II - Concrete ongoing standardisation activities supporting circular economy not covered in Rolling Plan 2020

This Annex provides an overview of standardisation activities that are already ongoing within standards developing organisations that are a member of the EU Multi-Stakeholder Platform on ICT Standardisation. This overview does not claim completeness. It is the result of a first round of input gathering.

Adding a chapter for the circular economy to the Rolling Plan 2021 is in progress and the information listed below will form a basis to be entered into this chapter.

CEN / CENELEC

The CEN-CENELEC Strategic Advisory Body on Environment (SABE) launched a new Joint Group on Circular Economy (JG-CE). The purpose of this Group is to provide advice and coordinate CEN and CENELEC's standardisation activities related to the Circular Economy.

https://www.cencenelec.eu/news/brief_news/Pages/TN-2020-018.aspx

More than 20 CEN and CENELEC Technical Committees are developing standards in support of various Ecodesign and Ecolabelling product regulations (through standardisation requests/mandates). Approximately 150 ENs were published (covering products such as: computer and computer servers, televisions, external power supplies, etc.). standardisation work related to energy efficiency mainly focused on the energy efficiency of products during their use phase. Moreover, as part of the Circular Economy Action Plan published in 2015, the European Commission requested to develop standards on material efficiency that would establish future ecodesign requirements on, amongst others, durability, reparability and recyclability of products.

CEN/CLC/JTC10: Energy-related products - Material Efficiency Aspects for Ecodesign

A full list of new standards - EN 4555X - was recently released addressing specific aspects of circular economy:

- EN 45552:2020 'General method for the assessment of the durability of energy-related products';
- EN 45553:2020 'General method for the assessment of the ability to remanufacture energy-related products';
- EN 45554:2020 'General methods for the assessment of the ability to repair, reuse and upgrade energy-related products';
- EN 45555:2019 'General methods for assessing the recyclability and recoverability of energy-related products';

- EN 45556:2019 ‘General method for assessing the proportion of reused components in energy-related products’;
- EN 45557:2020 ‘General method for assessing the proportion of recycled material content in energy-related products’;
- EN 45558:2019 ‘General method to declare the use of critical raw materials in energy-related products’;
- EN 45559:2019 ‘Methods for providing information relating to material efficiency aspects of energy-related products’.

https://www.cenelec.eu/dyn/www/f?p=104:7:1943408107517001::::FSP_LANG_ID,FSP_ORG_ID:25,2240017#1

Further on battery and circular economy: https://www.cencenelec.eu/news/publications/Publications/CEN-CENELECCircularEconomyAccess_rev2020-05-V1.pdf

CEN/TC 319 “Maintenance”: various working groups, etc. are currently working on standards for “Maintenance Management” and “Maintenance Engineering”. These standards are intended to concretize and standardize basic tasks, role definitions and methods in the maintenance process of Industrie 4.0 installations

CENELEC TC 59 X WG 23 – Resource efficiency: European Standards on methods of measurement of characteristics that are of importance for determining the performance of electrical appliances for household use or of electrical appliances for commercial use. The dedicated methods for measuring the energy performance of energy-related products developed by CLC/TC 59X help manufactures to measure the energy efficiency of their products against the thresholds laid down in Ecodesign and Energy Labelling Regulations adopted by the European Commission.

Green Electronics Council

EPEAT is an IT sector ecolabel for purchasers, manufacturers, resellers and others wanting to find or promote environmentally preferable products. The EPEAT program provides independent verification of manufacturers' claims through Conformity Assurance Bodies evaluating products against EPEAT criteria. The EPEAT criteria are developed through a balanced voluntary consensus process. Standards that the EPEAT Program has historically adopted were created by Standards Development Organizations (SDOs) employing balanced voluntary consensus processes but are now developed through the Green Electronics Council Dynamic Standards Development Process (DSDP). The EPEAT online Registry lists sustainable products from a broader range of manufacturers than any comparable ecolabel. National governments and thousands of private and public institutional purchasers around the world use EPEAT as part of their sustainable procurement decisions. See https://greenelectronicscouncil.org/epeat/epeat-overview/

ETSI

ETSI TC ATTM (Access, Terminals, Transmission and Multiplexing) issued EN 305 174-8, supported by European Commission and based on EU WEEE (Waste Electrical and Electronic Equipment) and RoHS (Restriction of Hazardous Substance) Directives. This EN and the TS 105 174-8 Series are some

fundamental steps to improve the collection and treatment of ICT WEEE, promoting the circular economy regarding the amount of e-waste generated each year. The content of WEEE needs to be processed carefully due to the presence of both hazardous and precious substances.

ETSI TC EE (Environmental Engineering) has produced TR 103 476 “Circular Economy (CE) in Information and Communication Technology (ICT); Definition of approaches, concepts and metrics” and is producing an EN on “Assessment of material efficiency of ICT network infrastructure goods (circular economy)” in the scope of Mandate M/543 on Material Efficiency on which the work is done in coordination with CEN/CLC/JTC10. Furthermore, EN deliverables are in preparation for the circular economy requirements specific to servers.

GS1

GS1 global and open standards provide a common language to identify, capture and share supply chain data about products, locations, assets and more. Companies usually combine different GS1 standards to ensure compliance and to streamline processes https://www.gs1.org/standards

The Global Trade Identification Number - GTIN is the most used product identifier by companies globally and Data attributes included in the GTIN (e.g., serial number, regulatory requirements ...) support regulatory and business needs. https://www.gs1.org/standards/id-keys/gtin

The GS1 Digital Link standard extends GS1 identifiers by making them part of the web and by enabling connections to all types of business-to-business and business-to-consumer information. This could support the circular economy model in making data available in a smarter way directly from trusted sources and through open standards. https://www.gs1.org/standards/gs1-digital-link

The GS1 Global Traceability Standard defines a minimum set of traceability requirements within business processes to achieve full chain traceability, independent of any technology. It outlines a common framework to build a traceability system using GS1 standards – such as barcodes, data carriers and EPCIS. This standard allows an end-to-end traceability system, linking the flow of information to physical products. https://www.gs1.org/standards/traceability/how-traceability-standards-work

GS1 is working with other stakeholders in Europe to develop a circular data model allowing interoperability across sectors and data spaces https://www.gs1.eu/news/circular-data-for-a-circular-economy

IEC

The following horizontal standards are available or being developed:

- EN IEC 60086-6:2020 'Primary batteries - Part 6: guidance on environmental aspects'
- EN IEC 63115-1 'Secondary cells and batteries - Sealed nickel-metal hybrid cells and batteries for use in industrial applications - part 1: Performance
- prEN IEC 63218 'Secondary cells and batteries - Secondary lithium ion, nickel cadmium and nickel metal hybrid cells and batteries for portable applications - guidance on environmental aspects'

- IEC TS 61851-3-7 'Electric vehicles conductive power supply systems - particular requirements for EV supply equipment - battery system communication'
- prEN IEC 62933-4-4 'Electrical energy storage systems - environmental requirements for BESS using reused batteries in various installations and aspects of life cycles'

Predictive maintenance is another current standardisation focus on maintainability. Ongoing activities are IEC 63270 ED1 “Industrial automation equipment and systems – Predictive maintenance“ within IEC/SC 65E.

ISO

ISO/TC 323, Circular economy, was formed in 2018 to address standardisation in the field of Circular Economy to develop frameworks, guidance, supporting tools and requirements for the implementation of activities of all involved organizations, to maximize the contribution to Sustainable Development. The following working groups are active:

- WG1: Framework, principles, terminology, and management system standard.
- WG2: Guidance for implementation and sectoral applications.
- WG3: Measuring circularity.
- WG4: Specific issues of circular economy type of business models (PSS,....).

https://www.iso.org/committee/7203984.html

ISO/TC 324, Sharing economy, was formed in 2019 to address standardisation in the field of sharing economy. The following working group is active: WG1: Terminology and principles.

https://www.iso.org/committee/7314327.html

ISO 13374 on condition monitoring and diagnostics of machines during the processing, exchange and presentation of data.

https://www.iso.org/standard/37611.html

ISO 13381 describes the principles for prognosis in the context of condition monitoring and diagnostics of machines.

https://www.iso.org/standard/51436.html

ITU

The ITU has developed a series of international standards that support the transition to circular economy at city level and encourage re-use, recycling and circular design and more in the ICT industry, including:

- Recommendation ITU-T L.1020 “Circular economy: Guide for operators and suppliers on approaches to migrate towards circular ICT goods and networks”
- Recommendation ITU-T L.1022 “Circular economy: Definitions and concepts for material efficiency for information and communication technology”
- Draft Recommendation ITU-T L.1023 “Assessment method for Circular Scoring” (under approval process)
- Recommendation ITU-T L.1100 “Procedure for recycling rare metals in information and communication technology goods”
- Recommendation ITU-T L.1032 “Guidelines and certification schemes for e-waste recyclers”
- Recommendation ITU-T L.1021 “Extended producer responsibility - Guidelines for sustainable e-waste management”
- Recommendation ITU-T L.1031 “Guideline on implementing the e-waste reduction target of the Connect 2020 Agenda”

Additionally, ITU is working on the following international standards:

- Draft Recommendation ITU-T L.ARCH_EoL_CE “Environmental Impact of architecture solutions with regards to End of Life and Circular Economy (CE)”
- Draft Recommendation ITU-T L.CE_Industry 4.0 “Circular Economy and Industry 4.0”
- Draft Recommendation ITU-T L.E-waste-collection “Guidelines on the collection, pre-treatment, dismantling, valorization and final disposal of WEEE“
- Draft Recommendation ITU-T L.ICT_CE “ICT response to circular economy”
- Draft Recommendation ITU-T L.Mat_frame “Assessment of material efficiency of ICT network goods (circular economy). Part 1: General for server and data storage equipment”
- Draft Recommendation ITU-T L.ME_AF “Assessment of material efficiency of ICT network infrastructure goods (circular economy). Part 3: Server and data storage product availability of firmware and of security updates to firmware”
- Draft Recommendation ITU-T L.ME_DD “Assessment of material efficiency of ICT network infrastructure goods (circular economy). Part 2: server and data storage product secure data deletion functionality”
- Draft Recommendation ITU-T L.ME_DIS “Assessment of material efficiency of ICT network infrastructure goods (circular economy). Part 5: Server and data storage product disassembly and disassembly instruction”
- Draft Recommendation ITU-T L.ME_RM “Assessment of material efficiency of ICT network infrastructure goods (circular economy). Part 4: Server and data storage product critical raw materials”

The ITU recently worked with the Basel Convention, Climate KIC and other partners to include ITU's green ICT standards in the world's first Massive Open Online Course (MOOC) on e-waste management, which include lessons on the role of ICT standardisation in the circular economy.

ITU also recently organized webinars on e-waste management and circular economy - E-waste Challenge MOOC live events.

Additionally, the United for Smart Sustainable Cities (U4SSC) initiative, which is led by the ITU together with UNECE and UN-Habitat with the support of 14 other UN Agencies and Programmes, recently published "A Guide to Circular Cities".

ITU is one of the partners of the Circular Economy Partnership which is being led by the WBCSD. This partnership aims to drive a coordinated transition towards an economically viable circular industry that maximizes value of products and materials throughout the full life cycle.

National Standardisation Bodies' activities

National Standardisation Bodies are recognised by national governments and are the national members of ISO, IEC and CEN, CENELEC. They also fulfil the role of NSO in the context of ENs developed in ETSI and many National Standardisation Bodies are also members of ETSI. National Standardization Bodies also develop national standards on a wide range of topics, where European and International standardization is not active, and have national initiatives.

DIN/DKE are the National Standards Bodies for Germany. DIN and DKE are involved in several activities regarding Circular Economy:

Digital Nameplate

DIN SPEC 91406 describes an approach that solves the challenge of assigning a unique URL in a concisely recognizable QR code. Committee DKE/K 241 published the preliminary standard DIN VDE V 0170-100 as a draft. The concepts developed are universally applicable and can therefore be transferred and extended to practically all branches of industry.

In the German Roadmap Industrie 4.0 the following further actions are recommended:

- The approaches for a Digital Nameplate as in DIN SPEC 91406 (according to the PAS method) and VDE V 0170-100 are to be continued and implemented internationally in a suitable form.
- Adaptations in all application standards for machine-readable marking along the lines of DIN VDE V 0170-100 together with DIN SPEC 91406 System life cycle, life cycle record.
- The model for the digital life cycle record based on DIN 77005-1 is to be regarded as a sub-model of the AAS (Asset Administration Shell). The specification of the AAS metamodel, available since the end of 2018, provides the necessary basis for this. It is recommended that the sub-model for the life cycle record be further elaborated and supported by the international standardisation work on the administration shell within IEC/TC65 WG 24 .

System life cycle, life cycle record

In production as well as in the entire life cycle of products, technical equipment and entire production systems, much data accumulates that can be made usable. Ideally, the entire life cycle data of technical

plant and all Industry 4.0-components are collected in the same form in administration shells and made available throughout the entire life cycle (with specific access rights). The contents are differentiated into type and instance life cycle data.

DIN 77005-1 “Life cycle record for technical objects“ specifies how information on plants and their parts is managed in a structured manner. A digital life cycle record is understood to be a holistic information technology support for the implementation of the requirements in DIN 77005-1.

Other models of life cycle record to be integrated include those described in IEC 82045-2, IEC/TS 62771, W3C SOSA and IEC 62507.

The life cycle record and the administration shell for Industrie 4.0-components pursue basically the same objectives and share a broad normative basis. The life cycle record is therefore suitable for inclusion in the standardisation work on Industrie 4.0 as a sub-model of the administration shell. The model of the life cycle record goes far beyond the already published administration shell model in VDI 2770.

Maintainability

DIN EN 60300-3-10:2015-01: Describes basic aspects of maintainability, in particular, the vertical and horizontal integration of systems results in new solutions in Industry 4.0 that require these aspects to be supplemented.

DIN EN 62402-09: Sets out requirements governing obsolescence management of objects and deals with all types of objects, the availability of which may come to an end during the life cycle of the product.

DIN EN 17007: Describes the essential processes of a comprehensive maintenance organization with their interrelationships, thus ensuring a uniform understanding of the processes of all those involved in maintenance.

DIN EN 16646 on maintenance within asset management shows the understanding of roles and thus also the key position of maintenance in the life cycle of an Industrie 4.0-plant.

Recommended further actions:

- Consideration of maintenance aspects both from the point of view of the manufacturer and the operator or user, also and in particular with regard to standards on predictive maintenance;
- Use of uniform maintenance terminology compliant with DIN EN 13306:2018-02 in all standards in which maintenance aspects are included;
- Consideration of harmonized process interfaces as in DIN EN 17007:2018 in all standards with process specifications on maintenance;
- Evaluation of all stipulations governing Industrie 4.0-solutions in terms of controllability of possible risks of obsolescence as in DIN EN 62402-09,
- standardisation of the interfaces of Industrie 4.0-components (plants and products) for the input of current maintenance information, e.g. on the basis of iiRDS (repairs, maintenance, conversions) into the systems of condition monitoring and predictive maintenance;

- Investigation into the internationalization of VDI 2770 Part 1 on minimum requirements for digital manufacturer information;
- Active participation of German experts in the standardisation project IEC 63270 ED1 “Industrial Automation Equipment and Systems – Predictive maintenance“ with Chinese coordination;
- Internationalization of VDI/VDE 3711 Part 1 “Input and transmission of maintenance information for condition monitoring – Digitalization of offline information“. A timely examination of the internationalization efforts is to be carried out by the national mirror committee DKE/K 931.

OASIS OPEN

The eDelivery Building Block of the Connecting Europe Facility uses implementation guidelines for various OASIS technical specifications, in particular a profile of the OASIS AS4 standard (also ISO 15000-2). It is widely used in the public and private sector, not just to replace paper, but also to support innovative business processes and services. As a relevant example, eDelivery is used by suppliers of electrical products to register products in the European Product Database for Energy Labelling (EPREL) and for the Poison Centres Notifications of the European Chemicals Agency. While these are central systems, eDelivery also supports distributed, peer-to-peer exchanges, so market participants could also use it more widely for exchange of product or other circular economy related data.

The eDelivery Building Block is also used in a new CEF OOP Building Block, aimed at supporting the so-called Once Only Principle for data use. Its first use will be to support data exchange required by the Single Digital Gateway regulation, but the building block is general purpose and supports arbitrary secure data sharing and could be used for secure and reliable data sharing supporting the circular economy. Besides CEF eDelivery, this new Building Block plans to use the OASIS RegRep4 standard as well as open data vocabularies developed by the ISA2 action.

OASIS UBL v 2.1 (ISO/IEC 19845) enables public sector procurement, including product reuse and sustainability analysis and has granular item description information structures to represent and exchange parts and materials data exchange. OASIS Product Life Cycle Support from the PLCS Technical Committee, which developed and issued data exchange templates ("DEX") to augment the product management works of ISO TC 184/SC4 on industrial data (particularly ISO 10303 "STEP"). Use of these now-well-established open methods like UBL and STEP enhances the ability of suppliers and procuring agencies to comparably track and coordinate re-use over product lifecycles.

tekom iiRDS Consortium

The iiRDS standard (intelligent information Request and Delivery Standard) enables the provision of intelligent maintenance-relevant information independent of industries and manufacturers. One goal of the iiRDS consortium, founded in 2018, is the specification of standardized mechanisms and a standardized vocabulary, which, in the context of Industrie 4.0, make it possible to generate situation-specific and context-specific information for the cases occurring throughout the product life cycle.

The following functions, among others, are to be fulfilled:

- dynamically adapt to the user and application context
- provide targeted information for all life cycle phases, from specification to maintenance
- match the delivered system, even after configuration changes and updates
- dynamically integrate assistance and sensor information and operating parameters
- support various search and filter functions.

The metadata of the iiRDS thus represent a standardised vocabulary for technical documentation. The iiRDS consortium is currently cooperating with the committee responsible for VDI 2770 to ensure the compatibility of that guideline.

UN ECE

Circular economy is one of the key themes of the work of the United Nations Economic Commission for Europe; it will be the main discussion theme of the commission session in April 2021. As input to discussions a Briefing Note on the United Nations Economic Commission for Europe – United Nations Centre for Trade Facilitation and Electronic Business Contribution to Advance Circular Economy Actions has been developed outlining policy positions as well as activities in standardisation with relevance to the circular economy:

http://www.unece.org/fileadmin/DAM/cefact/cf_plenary/2020_Plenary/ECE_TRADE_C_CEFACT_2020_24E-UNCEFACTdeliverablesCE.pdf

UNECE & UN CEFACT, and financed by the EU aiming at developing the recommendations and tools for transparency and traceability in the apparel & footwear industry (https://www.unece.org/info/media/news/trade/2019/transparency-in-fashion-unece-mobilizing-industry-and-experts-to-develop-blockchain-traceability-tool-and-policy-framework-under-eu-funded-project/doc.html).

This exercise involves the development under the aegis of UN CEFACT of a standard for communicating along value chains relevant information allowing to substantiate claims.

W3C

By building a web of data, W3C's strategy of data interoperability is directly and crucially relevant to the circular economy. The initiative is based on the Linked Data stack already specified that allow for re-use of existing tools like the specification on provenance of data. Relevant ongoing is work on is taking place especially in the Web of Things WG and in the Data Privacy Vocabulary CG.

Together with GS 1 W3C developed an analysis and action plan for standard around identifiers, semantics, vocabulary. This paper is available at:

https://www.gs1.eu/news/a-standards-based-knowledge-system-for-the-circular-economy

Annex III - Perspectives from the SMEs and societal stakeholders

ANEC

Consumers accept that ICT is an enabler in the circular economy, but on the other hand ICT products are also generating an increasing amount of waste. We need to ensure material efficiency in this area, and ensure that ICT products will be given more attention in the scope of the Ecodesign legislative framework.

Software (firmware) is becoming more and more critical in products. Proper consideration needs to be given to the reparability of such software. Properly repairable and upgradable software can in many cases substantially influence the longevity of products. Software (especially security) updates should be tackled from an overarching point of view and meaningfully included in individual standards.

An example of the potential to do this is the proposed new standard for Circular Ready Design. ANEC is asking for “circular software” to be taken into account within this standard. Software should be meaningfully included in individual material efficiency standards.

Another aspect needing attention is the standardised terminology of material efficiency standards. It is important to ensure that this is used throughout policy actions as well as when transferred to product-specific standards. CEN-CENELEC JTC 10 – “Energy-related products - Material Efficiency Aspects for Ecodesign on material efficiency” should provide a wide range of support to facilitate this, and align terms used in European Commission’s Green Deal and Circular Economy action plan, with the aim of not repeating or duplicating work and therefore effectively meeting the higher demand for CE-supporting standards in different CEN-CENELEC bodies.

ECOS

The European Green Deal and its Circular Economy Action Plan lay out a bold and ambitious plan to transition from a “throwaway” economy to a clean and circular one. While the plan seems to work very well on paper, its realisation depends on an equally ambitious and timely execution of the underpinning initiatives and policies, as well as a recognition that the EU Green Deal should be a key pillar of any economic stimulus following the COVID-19 pandemic. ECOS advocate for a holistic view regarding the green transition and circular economy addressing the various levels:

Product design and producer responsibility: Product design constitutes the most important stage in a product’s lifetime when it comes to minimising its environmental impact. Expanding ecodesign principles to all sectors is a very positive proposal from the European Commission. For the new framework to reach its full potential,

methods and standards need to be developed across a wide range of products, covering a number of aspects, from energy efficiency to material efficiency and from chemicals to microplastics.

Achieving circular electronics, ICT products and batteries: In order support the European Commission's ambition to achieve circular electronics, standards should be developed on a number of aspects including energy efficiency, durability, repairability, upgradeability, reuse and remanufacture, material use and chemical content.

Empowering consumers and public buyers: Empowering consumers and public buyers by providing credible information is needed to encourage sustainable purchasing decisions and reward products with low environmental impact. Standardisation should be employed in this field to support everyone's right to repair, trustworthy and relevant labels as well as well-founded and accurate environmental claims in order to minimise the risk of greenwashing and misleading green claims.

Reaching circularity in production processes: Achieving genuine circularity requires commonly agreed definitions of what 'circular' means as well as harmonised circular metrics applied to organisations and processes to support sharing and collaborative economy and sustainable product-as-service models.

Preventing waste: Apart from the methods that can facilitate waste prevention at design stage, standards can contribute to preventing waste, enhancing circularity and creating favourable conditions for secondary raw material use.

Increased monitoring and enforcement: Standardisation has a role to play in market surveillance not only in exploring the development of alternative verification procedures but also in making sure standards are properly developed in full compatibility with provisions.

ECOS and the environmental NGO community are ready to support the standardisation system with technical expertise and policy guidance. A more detailed proposal on what the standardisation system should deliver as relates to the environment and the ICT sector can be accessed here.

Small Business Standards/DIGITAL SME

https://www.digitalsme.eu/sustainable-digitalisation/

Since 99% of companies in Europe are SMEs, the European Commission's vision for the twin transition needs to be translated into SMEs ability to embrace climate neutrality and digitalisation – the two pillars of transforming Europe to a globally competitive, climate-neutral digitalised economy and society. This depends on three interconnected dimensions (1) Sustainable B2B Digitalisation, (2) Green(er) Technologies and Circular Economy - right to repair, access to data and adequate competition rules that ensure an open after-sales market, and (3) An Innovation-Enabling Policy and Regulatory Framework.

SMEs are a driving force for Digitalisation and Circular Economy:

European digital enterprises, especially SMEs, can play a decisive role in digitalising the economy — if there is a level-playing field and if Europe invests in them. At the same time, it is important that the digital transformation takes place in a sustainable manner and supports the environmental goals of the Green Deal and the Circular Economy Plan.

Fair access to open data is essential to maintain circularity:

For these transition strategies to be effective in helping Europe reach its environmental goals, the digital sector has to contribute its share and embrace sustainability:

- In all its facets: circular economy models for hardware, climate-neutral CPU models and server centres, software advancements to reduce energy consumption, and many more.
- Within all [non-digital] sectors to integrate them in the wider system and transform waste into resource – Ex. Construction, energy, connected devices, Lifts, etc.

By enhancing repairability and third-party maintenance, the life cycle of products could be extended. This would not be entirely possible without the ability of third-party access to open data. Only if independent companies that perform repair and maintenance services have access to the products' data, we can have a competitive secondary market, where many SMEs can thrive and drive economic growth and employment, consumers spend less and products life-cycle be extended.

ESOs can drive forward the twin transition through supporting SMEs in standardisation:

Due to their privileged role and industry participation, European Standardisation Organisations (ESOs) are in a good position to offer more support to European SMEs that embrace digital transformation and circularity through standardisation. While ICT standards are the result of a collaborative approach that combines R&D efforts from different sources to offer innovative technologies, the adoption of such technologies by companies, especially SMEs, cannot happen through standards alone. Developing the best state-of-the-art standards does not automatically translate into their adoption by SMEs. In addition, SMEs in many sectors struggle to find reliable sources of information and knowledge, as well as use cases about the adoption of new technologies.

Innovative technologies such as Blockchain promotes "openness" and helps in creating distributed networks to leverage the resources of multiple different actors, and in doing so create user-generated open markets. In this sense, Blockchain becomes an enabling tool to create, organize and manage new forms of Circular Economy networks. Thus, Blockchain becomes the tool that coordinates these technologies by offering security, privacy and decentralisation of data and information flow within networks.

ESOs have a chance to serve strategic EU interests by investing more in providing guidance, practical instructions and even a long-term vision to European companies in the digital transformation and circular economy by:

- Relying on specifications that enable the integration of standards technologies into specific sectors.
- Developing guides for implementation of technology standards in SMEs
- Raising awareness about standards-enabled technologies among SMEs
- Bridging the gap between standardisation and research for innovative SMEs and start-ups