European Commission

JRC TECHNICAL REPORT

Linking research and innovation with standardisation

Operational activities in the collaboration between JRC and CEN-CENELEC

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2021

EUR 30808 EN

EU Science Hub
https://ec.europa.eu/jrc

JRC125392

EUR 30808 EN

PDF ISBN 978-92-76-41076-8 ISSN 1831-9424 doi:10.2760/630783

Luxembourg: Publications Office of the European Union, 2021

How to cite this report: Andreas Jenet, Livia Mian, Samira Nik, Fabio Taucer, Ashok Ganesh, Luc Van den Berghe, *Linking research and innovation with standardisation: Operational activities in the collaboration between JRC and CEN-CENELEC*, EUR 30808 EN, Publications Office of the European Union, Luxembourg, 2021, ISBN 978-92-76-41076-8, doi:10.2760/630783, JRC125392.

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Acknowledgements

The authors thank the social media teams of CEN, CENELEC and JRC for the dissemination actions and the designer Angel Alvarez Martinez for the continued support in establishing visual solutions.

Abstract

This report reflects the agreed collaboration carried out between the European Committee for Standardization (CEN), the European Committee for Electrotechnical Standardization (CENELEC) and the Joint Research Centre of the European Commission (JRC) covering the years from 2016 to 2021.

Standardisation and the collaboration with technical committees are important aspects for JRC experts to disseminate pre-normative research outputs. The collaboration may not only result in knowledge exchange of the produced research results, but may contribute to the capacity to deliver scientific advice to other Commission services and the drafting of the Annual Union Work Plan for standardisation.

Activities can be summarised in three main categories. Firstly, in strengthening the linkage between research and innovation with standardisation, which was reinforced by the Joint Initiative on Standardisation, by the workshop series Putting-Science-into-Standards and through ad hoc inputs to EU policy areas and involvement in coordination platforms. Secondly, the collaboration facilitated the participation of JRC experts in technical committees of the European standardisation organisations. Thirdly, joint training and awareness-raising initiatives were organised and carried out to promote increased participation of researchers in standardisation activities.

While strengthening current achievements, the capacity to anticipate standardisation needs, as well as international adoption of European norms are aspects that deserve more attention in future collaborations with CEN and CENELEC.

1 Introduction

This report presents outcomes of the collaboration[1] carried out between the Joint Research Centre of the European Commission (JRC) and the European Committee for Standardization (CEN), the European Committee for Electrotechnical Standardization (CENELEC) signed on 20 October 2016.

Specifically, this report highlights the achievements in the collaboration towards linking research and innovation with standardisation, followed by reporting on the facilitation of the participation of JRC experts in TCs and finally, by providing an overview of joint training and awareness-raising initiatives. It looks back on this longstanding cooperation on standardisation throughout a wide range of technical areas of pre-normative and co-normative research. This was already established under previous cooperation agreements that date back to June 2010 and November 2004 with the European Committee for Standardization.

Standardisation as a driver for innovation is of increasing importance for policy development. For this reason, strengthening the link between research, innovation and standardisation has been at the centre of the collaboration for the past 5 years. This was achieved on the one hand by taking up a leading role in the Joint Initiative for Standardisation (JIS) hosted by DG GROW, the collaboration and support to various European standardisation platforms and most importantly by the further development of the "Putting-Science-into-Standards" (PSIS) workshops as a standardisation foresight instrument.

Although the JRC is not a standardisation organisation, majority of its activities relate to standardisation, pre-normative research and harmonisation. CEN and CENELEC therefore represents an important and natural partner for the JRC. The agreement therefore facilitated the participation of JRC staff members in - and their contribution to standardisation technical committees (TC), sub committees and working groups.

CEN and CENELEC recognise scientific input into the standardisation processes as being crucial and the national standardisation bodies value the contribution JRC provides to CEN and CENELEC. Against this background, joint activities aiming at fostering common partnerships and platforms, and the active participation to the yearly assemblies, conferences, promotional events, training sessions and preparation of joint documents have become regular.

[1] Agreement number 34603

2 Activities linking research and innovation with standardisation

Standardisation is a process involving stakeholders in the development of national, European and international standards. One stakeholder group with a strong influence in the evolution of industry, technology and society is the research and innovation community. Strengthening their relationship has mutual benefits. A smooth and rapid market uptake of the research results, particularly generated by the EU framework programmes for research[2] is in the interest of European taxpayers, increases acceptance and benefits Europe as an innovation hub. Cooperation with the research community can ensure the timely inclusion of research results in standardisation activities. The JRC is the ideal partner for CEN and CENELEC to collaborate in this context, as the JRC is involved in several research programmes and consortia, and, on the other hand, offers expertise in pre-normative research through its membership in more than 80 technical committees.

Very prominently, the collaboration was reflected in the framework of the Joint Initiative on Standardisation. Under this umbrella JRC and CEN-CENELEC gathered use cases and strategies that bridge research and innovation to standardisation.

We report in this chapter the results of the Putting Science into Standards workshops, an initiative that taps strategically in the complementary resources of both organisations to identify novel technology fields that may benefit from future standardisation activities.

Ultimately, we list our involvement in common coordination and information platforms that aimed to enhance bringing research and innovation to standardisation, such as the BRIDGIT2 project and the STAIR platform.

2.1 Collaboration in the framework of the Joint Initiative on Standardisation

The Joint Initiative on Standardisation (JIS)[3] was implemented over a period of three years (2016-2019) and was a launch pad for mutually beneficial results and a shared vision. The initiative counted 15 actions in three cluster domains, with the purpose of increasing the use of standards and in having an inclusive process to promote high quality, market relevant and user-friendly European standards supporting European policies and European competitiveness globally, as well as to improve and to facilitate everyday life for citizens.

Firstly, the initiative strengthened the competitiveness of European businesses and enhanced societal welfare by supporting the development of the European standardisation system and by ensuring the delivery of timely and state-of-the-art standards.

Secondly, it supported EU policy priorities and objectives while respecting the roles of the various stakeholders, the national delegation principle and the different competences of the EU, EFTA and their Member States.

The JRC led Action 2: 'Linking research and innovation with standardisation' of the JIS, which aimed to encourage the natural collaboration between researchers, innovators and standardizers and to allow a smooth uptake of research and innovation outputs into standardisation. The action involved more than 20 stakeholder institutions and consisted of three work packages:

- Further develop and exploit foresight mechanisms
- Deepen research – standardisation integration
- Develop the European innovation eco-system

[2] Framework Programmes for Research and Technological Development for the period 2014–2020 https://ec.europa.eu/programmes/horizon2020/ and for the period 2021–2027 https://www.horizon-eu.eu/

[3] The Joint Initiative on Standardisation (JIS) was supported by hundreds of contributors representing European and national standardisation bodies, associations representing consumers, environmental interests, workers, industry and SMEs, and individual businesses from several sectors https://ec.europa.eu/growth/content/joint-initiative-standardisation-responding-changing-marketplace_en

The initiative extracted the most pressing challenges and issues concerning standardisation in 15 fields and outlined a pathway including use cases on how to tackle them. In linking research and innovation with standardisation, JRC and CEN and CENELEC established an ecosystem of engaged partners, several good practice examples were collected and linkages established with platforms bridging the gap between R&I and standardisation. Most importantly, Action 2 provided a strong case that led to DG R&I recognising the increased importance of standardisation in the EU Framework for Research and Innovation.

2.2 Putting-Science-into-Standards workshops

Putting-Science-Into-Standards (PSIS)[4] is a joint initiative developed by CEN, CENELEC and JRC with the aim to facilitate the identification of emerging science and technology areas that could benefit from standardisation activities to enable innovation and promote industrial competitiveness. PSIS workshops are to some extent a foresight exercise in which the JRC is exploring standardisation needs linked to emerging, mature technologies. PSIS workshops are landmark events aiming at mapping ongoing standardisation efforts and identifying existing gaps to assess and recommend actions needed to start the process of drafting new, or complementing existing standards. The recommended actions may lead to the proposal of a standardisation roadmap validated by the stakeholder audience of the PSIS workshop.

2.2.1 How to incorporate foresight in standardisation?

In standardisation, the importance of projecting technology needs and requirements into the future cannot be overstated. Foresight is a discipline that is used to help different stakeholders and experts to look into understanding and analysing possible future developments and challenges and supporting actors to actively shape the future.

The JRC foresight report on standardisation from 2014[5], was one of the central documents that guided the collaboration agreement of JRC and CEN-CENELEC. The report laid out the concept of the PSIS workshop and provides a guide to encourage own staff to scan the horizon for standardisation needs for which there is no technical platform available.

The PSIS initiative has proven to be a successful example of foresight activities aimed at the timely identification of emerging science and technology areas where standardisation activities are required to enable innovation and promote EU industrial competitiveness. Past examples have shown that PSIS can be an effective incubation track for future standardisation.

The Putting Science into Standards workshop series represents an effective follow up of the recommendations from the 2014 foresight report, facilitating the discussions between the scientific and standardisation communities and fully assessing the potential of scientific and technological developments.

Building on these results, further development could promote more joint efforts from JRC and CEN-CENELEC to better deploy foresight actions to timely meet the needs of a fast-changing global landscape and develop a consistent European standardisation agenda.

[4] https://ec.europa.eu/jrc/en/science-area/standards

[5] Scapolo F, Churchill P, Viaud V, Antal M, Cordova Gonzalez Castillo H, De Smedt P. How will standards facilitate new production systems in the context of EU innovation and competitiveness in 2025. EUR 27096. Luxembourg (Luxembourg): Publications Office of the European Union; 2014. JRC93699 https://www.doi.org/10.2788/46994

2.2.2 How to identify standardisation gaps, opportunities and other issues

The JRC and CEN-CENELEC and established in 2019 a procedure for the selection of PSIS topics. A selection committee was set up at the JRC to evaluate the proposals from its own staff on PSIS topics based on the following criteria:

- Research and innovation maturity
- Participation in research networks
- Involvement from industry
- Standardisation landscape
- Standardisation objectives
- European relevance
- Expected impact & proposed roadmap

Furthermore, the selection considers the relevance of the PSIS topics to EU policy areas, how they fit into EU priorities and their benefit to EU Regulations and Directives, including their contribution to European strategies with regard to industry. The selection process is outlined in Figure 1.

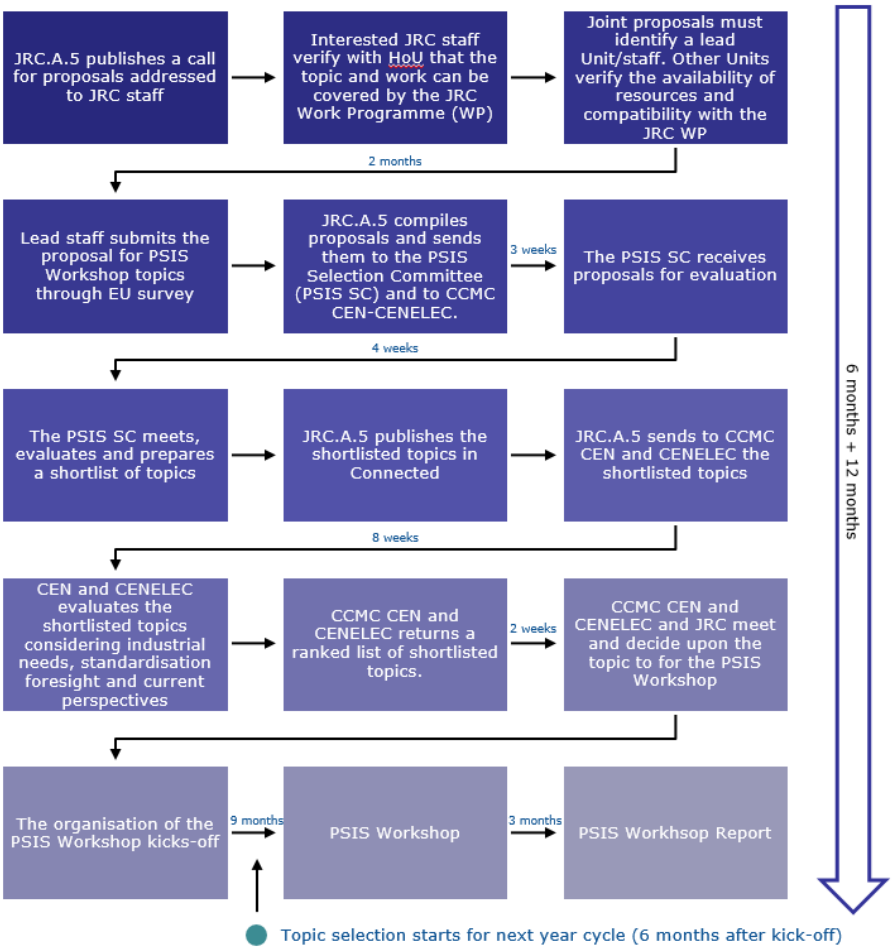

Figure 1 Workflow for Putting-Science-into-Standards workshops (JRC A.5 is the scientific development unit)

In 2020, five proposals were received thus:

- **Organ-on-chip**, a research proposal developed by a JRC team working in chemical safety and alternative methods. The proposal addressed the sectors of chemicals, consumer safety and healthcare and presented the innovative tools of Organ-on-Chips (OoCs) and Micro Physiological Systems (MPS), combining technology and biology. Although over 100 existing standards are referenced in the field of OoCs, no specific standard has yet been developed. The proposal anticipates the importance of OoC technology and potential standardisation activities. This proposal has been selected for the organization of a PSIS workshop in 2021.
- **Standards for Ecosystem service models for natural capital accounts**, a contribution from JRC team working on land resources, dealing with the valorisation of ecosystem services coming from natural capitals. The work includes ecosystem accounting based on a statistical framework for tracking changes. The system of environmental economic accounting, coordinated by the United Nations, brings together environmental and economic information into one common framework.[6] The proposal is timely and aligned to European political priorities with relevance for the European Green Deal.
- **Digital transformation and interoperability standards for energy technology data** from a JRC team working on nuclear laboratories and experimental equipment. A framework for developing interoperability standards i.e. in machine readable formats, that would allow any energy technology Technical Committee to adapt its documentary testing and qualification standards to the digital landscape
- **Damage and loss data** is a proposal submitted by the JRC disaster-risk-management unit in collaboration with finance and economy unit, technology innovation in security, safety & security of buildings and knowledge for health & consumer safety. The DRMKC Risk Data Hub database collects data from natural and technological hazards. Due to the lack of a harmonised data format and methodology for the analysis of disasters, its comparability is constraint. The proposal was evaluated as highly relevant and recommended for direct progressing with a CEN Workshop Agreement (CWA).
- **COVID-19 improved crisis management and business continuity capabilities through standards** is a proposal that was submitted by the Euratom coordination unit. Inspired by the COVID-19 pandemic, this standardisation proposal emphasizes the need to set out a work programme consisting of practical guidance for emergency management and for increasing the resilience of cities in the event of a crisis. Although topics may be narrowed down on specific needs for standardisation, the proposal was deemed suitable and relevant.

Of these proposals, the one on OoC was selected for a PSIS workshop in 2021, whilst all the others received ad-hoc follow up support, mostly assisting to link up with available professional platforms (i.e. technical committees from the European Standardisation organisations or from ISO) or to discuss the opportunity to start a CEN workshop agreement (CWA). CEN Workshop agreements can be considered as a pre-standard or consortium standards that have the opportunity to be transformed into a European norm (EN) relatively easily.

2.2.3 Planning, execution and follow-up of PSIS workshops

The preparation of a PSIS workshop involves the establishment of an organising committee, defining the scope, drafting of a rationale and agenda, the identification of speakers and stakeholder groups, the design of a visual identity, the announcement and registration website, selection of the venue and event preparation.

[6] Teller, A., Maes, J., Ivits, E., Petersen, JE., La Notte, A., Aizpurua S., Vallecillo, N., Vysna, V. Accounting for ecosystems and their services in the European Union (INCA). Final report from phase II of the INCA project aiming to develop a pilot for an integrated system of ecosystem accounts for the EU. www.doi.org/10.2785/197909

Six PSIS workshops have been held since 2013 addressing different fields of science. The following workshops took place in the frame of the cooperation agreement set up in 2016:

- "**Driving towards decarbonisation of transport**: Safety, performance, second life and recycling of automotive batteries for e-vehicles" organized in September 2016 at the JRC site in Petten (NL). The workshop focused on identifying standardisation and pre-normative research activities for automotive batteries to guide further deployment of e-mobility[7], realising the strategic energy transformation plan[8] towards a resilient energy union[9].
- "**Railways of the future**", organized in Brussels in October 2017, with the aim to address the challenges faced by the European railway industry with a focus on passenger experience, innovation and security[10], and jointly with the Joint Undertaking Shift2Rail to support the Energy Union Roadmap Action on "A strategic transport R&I agenda".[9]
- "**Making quantum technology ready for industry**" organized in March 2019 in Brussels. Quantum physicist and experts from different European countries working in different quantum disciplines gathered to discuss how to bring inventions to the market, thus completing the pathway of innovation.[11] This project supported Europe's largest research project the European Quantum Technologies Flagship[12] and provided an example for the EU valorisation policy for research.[13]
- "**Organ on chip**: Towards standardisation" held virtually in April 2021. The workshop gathered stakeholders from different fields to identify application areas for organ on chip technologies, to share views on future developments and stakeholder needs, and to provide recommendations to CEN and CENELEC on possible next steps.[14] This supports the EU directive[15] on the protection of animals used for scientific purposes to replace fully animal methods.

2.2.4 Expected results and impact

The PSIS workshops aim to facilitate the exchange of views on the future development of new technologies and to identify how European standardisation can support its full deployment. A PSIS workshop may lead to the development of a standardisation roadmap to identify market requirements facing a new technology, the creation of a formal structure under CEN or CENELEC to implement workshop outcomes, the identification of existing gaps in pre-normative research, or highlighting prerequisites for interfaces, requirements and interoperability.

To enhance the protection of European networked infrastructures and to prevent hazards in industrial installations, the JRC has been pursuing the development of quantum safe communications. Beside the JRC's work in cryptography, the team provides regular technology overviews on the European state of the art in quantum technologies and has been involved in the design phase of the European Quantum technology flagship.[16] The collaboration has led to the set-up of the PSIS workshop on quantum technologies. Building on the results of the PSIS workshop "making quantum technology ready for industry", the CEN and CENELEC Focus Group on Quantum

[7] https://www.doi.org/10.2790/113142
[8] C(2015) 6317
[9] COM(2015) 80
[10] https://ec.europa.eu/jrc/en/event/workshop/railways-future
[11] https://www.doi.org/10.2760/882029 and https://www.doi.org/10.2760/65881
[12] https://qt.eu/
[13] https://ec.europa.eu/info/research-and-innovation/research-area/industrial-research-and-innovation/eu-valorisation-policy_en
[14] https://ec.europa.eu/jrc/en/event/conference/putting-science-standards-organ-chip-towards-standardization
[15] EU Directive 2010/63
[16] https://doi.org/10.1038/d41586-018-07216-0

Technologies (FGQT)[17] was created to ensure the interaction between stakeholders, who belong to some part to the beneficiaries of the Commission's Directorate-General for Communications Networks, Content and Technology managed EU quantum flagship[18], interested in identifying standardisation needs in quantum technologies. Furthermore, the focus group recommend further actions to ensure that standards support the deployment of such technologies in industry.

A PSIS workshop traditionally results in a publication in the form of a JRC workshop report and, depending on the outcome of the workshop, in other publications including policy briefs, scientific papers, etc. The following publications related to PSIS events are available on the publication's office of the European Union:[19]

- Making quantum technologies ready for industry (workshop report)
- Making quantum technologies ready for industry (policy brief)
- Putting-Science-into-Standards: Driving towards decarbonisation of transport: Safety, performance, second life and recycling of automotive batteries for e-vehicles (workshop report)
- Putting-Science-into-Standards: Evidence-based quality assurance - an example for breast cancer (workshop report)

2.3 Ad Hoc collaboration and inputs to EU policy areas

The collaboration between JRC and CEN-CENELEC also offered input to EU policy, particularly where standardisation is relevant.

There were numerous interactions over the period 2016-2021 with Directorate-Generals following up on the PSIS topics. The JRC engaged with Commission bodies and linked this stakeholders and the corresponding JRC staff with CEN and CENELEC to discuss their proposals in greater detail.

With the start of the coronavirus pandemic, an ad-hoc scoping exercise[20] was launched to scan for needs in standardisation to confront the COVID-19 pandemic within the EU. These were:

Methods to share epidemiological information

- Improving the coordination and capabilities societal resilience
- Method to compute the effective reproduction number from data series
- Guidance of quality assurance in testing- and detection laboratories

2.4 Involvement in further coordination and information platforms

The CEN and CENELEC Technical Boards' Working Group for standards, innovation and research (BT/WG STAIR)[21] brings together standardizers, researchers and innovators in order to discuss and identify standardisation needs and opportunities for specific areas of concern.

Within the context of the earlier mentioned Joint Initiative of Standardisation, the JRC has been occasionally collaborating with BT/WG STAIR, as well as in Standard Days (CEN-CENELEC yearly

[17] https://www.cencenelec.eu/standards/Topics/QuantumTechnologies/Pages/default.aspx
[18] https://qt.eu/
[19] https://op.europa.eu/en/web/general-publications
[20] Jenet, Andreas; Nik, Samira; Mian, Livia; Schmidtler, Stella-Zoë; Annunziato, Alessandro; Marin-Ferrer, Montserrat; McCourt, Josephine; Lequarre, Anne Sophie; Ganesh, Ashok; Taucer, Fabio; Standardisation needs for COVID-19. Scoping exercise on potential standards gaps carried out among JRC scientists. Putting Science into Standards (PSIS), European Commission, Brussels, 2021, JRC121514. https://www.doi.org/10.13140/RG.2.2.16142.08004
[21] https://www.cencenelec.eu/research/ForMembers/Why/Pages/default.aspx

information session aimed at presenting the European Standardisation System) and COST Connect[22] actions of the European Cooperation in Science and Technology (COST Association).

Furthermore, the JRC was involved in the evaluation of the EC and EFTA co-financed consortium project "Bridging the Gap between Research and Standardization" (BRIDGIT2). The BRIDGIT2 project provided evidence that standardisation facilitated the market uptake of outcomes from European research programmes and developed a set of tools to support the engagement between the standardisation and R&I communities.

[22] COST Connect is a series of thematic workshops organised by the COST Association, which provide an open space for researchers, policy makers and research and innovation (R&I) stakeholders to network and grow their ideas.

3 Facilitation of the participation of JRC experts in Technical Committees

The Commission use standardisation in support of new or existing legislation and policies. These intentions may lead to formal standardisation requests. The obligation to identify strategic priorities for European Standardisation comes from legislation which defines the European standardisation system (EU) No 1025/2012. In order to support this, but in general to ensure that the pre-normative research is being taken up in standards that can be referenced in EU legislation to protect and ensure safety of EU citizens, JRC staff actively participate in CEN and CENELEC technical committees.[23] They are well-placed to provide input on pre- and co-normative research and to represent an interface between research and policymaking.

According to the CEN-CENELEC data repository, JRC is represented in 25 CEN technical committees (representing 60 different working groups), and in three CENELEC technical committees (representing 13 different working groups). Moreover, JRC staff are involved in two CEN-CENELEC joint technical committees, the energy-related products - material efficiency aspects for eco-design (CEN/CLC/JTC 10) and the hydrogen in energy systems (CEN/CLC/JTC 6). Overall, more than 50 JRC scientists are actively taking part in ongoing standardisation activities in different technical committees and working groups.

Additionally, JRC representatives are also involved in other CEN and CENELEC platforms including Focus Groups[24] on artificial intelligence, block-chain and distributed ledger technologies, on quantum technologies, the joint coordination group on eco-design / resource efficiency and the Sector Forum on energy management.

Occasionally JRC staff require assistance and have queries regarding the participation and approach to technical committees from CEN or CENELEC. Although, due to streamlined processes these requests are of much lower level compared to request concerning international standardisation bodies.

Sometimes, we coordinate queries from JRC staff concerning the duration or extension of CEN-CENELEC workshop agreements (CWA)[25], issues with reporting, reference letters, intellectual property rights and other specific technical fields.

[23] https://boss.cen.eu/technicalstructures/pages/tc/
[24] https://boss.cen.eu/media/CENELEC/ref/ir2_e.pdf
[25] https://boss.cen.eu/developingdeliverables/CWA/Pages/

4 Training and awareness-raising initiatives

In the following we list several training and awareness-raising events that were carried out jointly by JRC and CEN-CENELEC during the last five years. In these events, opportunities to coordinate European input to international standardisation (in ISO, IEC)[26] were identified. Furthermore, fostering the uptake of European standardisation products and services was prioritised. National, European and international levels as platforms for standardisation activities were presented. In addition, the mirroring aspect and potential uplifting of standards to international levels was discussed.

As an example, the EU's Quantum Flagship[27] asked us to organise a joint satellite event on standardisation and to explain in a training session for the quantum science community the interlinkages between European and international bodies.[28] Similar events were held in Vienna and Brussels.

Involvement in pre-standardisation activities has been explored also with JRC's European Reference Network for Critical Infrastructure Protection (ERNCIP)[29] during a series of dedicated meetings (ERNCIP conference November 2019, DRIVER+ workshop in Brussels in January 2020 (DIN and UNE) and June 2020). Several possibilities have been discussed for the uptake for ERNCIP Thematic Groups activities into standardisation, including the creation of a dedicated Sector Forum or Focus Group and the development of CWA.

In November 2019, the JRC and CEN-CENELEC organized the "Action for Standards" workshop[30] with COST connect, addressing key issues relating to the field of standardisation, including how to develop better synergies between COST actions and standardisation activities and how to better facilitate the voice of research in standards at the pan-European level. The COST connect program[31] is a series of thematic workshops organised by the COST association, which provide an open space for researchers, policymakers and research and innovation (R&I) stakeholders to network and grow their ideas. It brings together a broad set of actors from the European Research Area (ERA) and beyond with the aim to stimulate and strengthen multi-stakeholder partnerships. Following the successful event, in 2020 the COST academy organized two webinars on the topics of intellectual property (IP) and standardisation involving the European IP Helpdesk and CEN and CENELEC.

The Putting Science into Standards workshop on quantum technologies established through the European Metrology Programme for Innovation and Research (EMPIR) a close collaboration with the European association of metrology institutes (EURAMET)[32]. In fact, EURAMET recently launched the European Metrology Network for Quantum Technologies[33], which ensured a significant presence of national metrology institutes working in quantum science in the workshop. Beside the American metrology institute NIST[34], standards institutes from Canada, China, Japan and Korea also sent delegates.

Another activity was for JRC and CEN-CENELEC to coordinate appropriate treatment and clarifications on questions about legal issues and intellectual property protection. In particular on issues raised by JRC scientists involved in standardisation committees, e.g., a frequently clarifications concerning the exploitation rights of intellectual property by the original copyright holder of a contribution to the European standardisation process is being requested. This is being tackled case by case with the JRC Central IP service.

[26] The Commission recognised international standardisation organisations are the International standardization Organization (ISO), International Electrotechnical Commission, and the International Telecommunication Union (ITU)
[27] https://qt.eu/
[28] https://eqtc19.sciencesconf.org/data/pages/EQTC_2019_Full_programme_V4.pdf
[29] https://erncip-project.jrc.ec.europa.eu/
[30] https://www.cost.eu/standards-make-the-world-go-round/
[31] https://www.cost.eu/cost-events/cost-connect-standards/
[32] https://www.euramet.org/
[33] https://www.euramet.org/european-metrology-networks/quantum-technologies
[34] https://www.nist.gov/

5 Conclusions

The collaboration between JRC and CEN-CENELEC is very active and immensely productive for all concerned. It can be viewed as a collaboration in three levels.

The basic level can be categorised as a liaison activity concerning continuous contacts related to JRC staff in technical committees. Tasks range from promoting collaboration results, synchronising lists of participation, and guidance on how JRC staff can be best incorporated and have access to the standardisation process.

The second level promotes linking research and innovation with standardisation and relates to the mutual benefits of the institutional collaboration. It is about how scientific staff, linked to corresponding science communities, can play a role in determining and creating standardisation platforms in fields where CEN and CENELEC identified a gap.

The third level highlights the contribution the partnership can play by making the EU Framework Programme for Research and Innovation more efficient. Involving academia and researchers in standardisation will benefit science and will ultimately make EU investments in research more efficient and effective by providing a clear pathway of valorisation of the obtained research results.

The standardisation system seems currently not sufficiently equipped to anticipate future standardisation needs, hence it is very important to build early linkages and to involve academia and researchers as an important client category in the European standardisation system. Technologies characterised with low technology readiness levels can benefit significantly from standardisation in laboratory processes[35] which in turn allows comparability in research. Several emerging and novel technology fields lack by nature[36] knowledge and experience of standardisation. Bridging this "valley of death" from innovative EU funded science to standardisation, can accelerate market access for the research results and lead to visible benefits for scientific investments. Developing technologies to serve devices and application requires a bottom-up approach[37] in standardisation, Putting Science into Standards could be the first step towards this goal.

Combining the three levels represents for JRC and CEN-CENELEC a very attractive and fruitful collaboration which further needs to be consolidated and expanded in all technology fields. In future, further attention should be provided to the anticipation aspect and foresight of emerging technologies were standardisation could be of benefit. Although working in a European framework, a global dimension could be further elaborated, widening the scope to Asian and African contexts and revisiting international upscale mechanisms.

[35] i.e. standard operational procedures, terminology, metrology, guides and processes

[36] Standardisation activities commonly start when the technology is mature and the end users (industry) consolidate their options. In emerging technologies, however, most staff in research and innovation have been seldom exposed to standardisation (i.e. Quantum, AI, Blockchain, Organ on Chip/microphysiological systems etc) and hence is dramatically underrepresented in respective platforms leading to a delayed uptake of research results in the market (the "valley of death").

[37] The end users of standardisation, often the industry, benefit from an early start in standardisation. A standardisation platform brings together scientists, engineers, developers, system integrators, marketing experts and regulators to work jointly towards removing barriers from a joint collaboration.

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doi:10.2760/630783

ISBN 978-92-76-41076-8