European Commission

Scoping study for supporting the development of a code of practice for researchers on standardisation

Final Report

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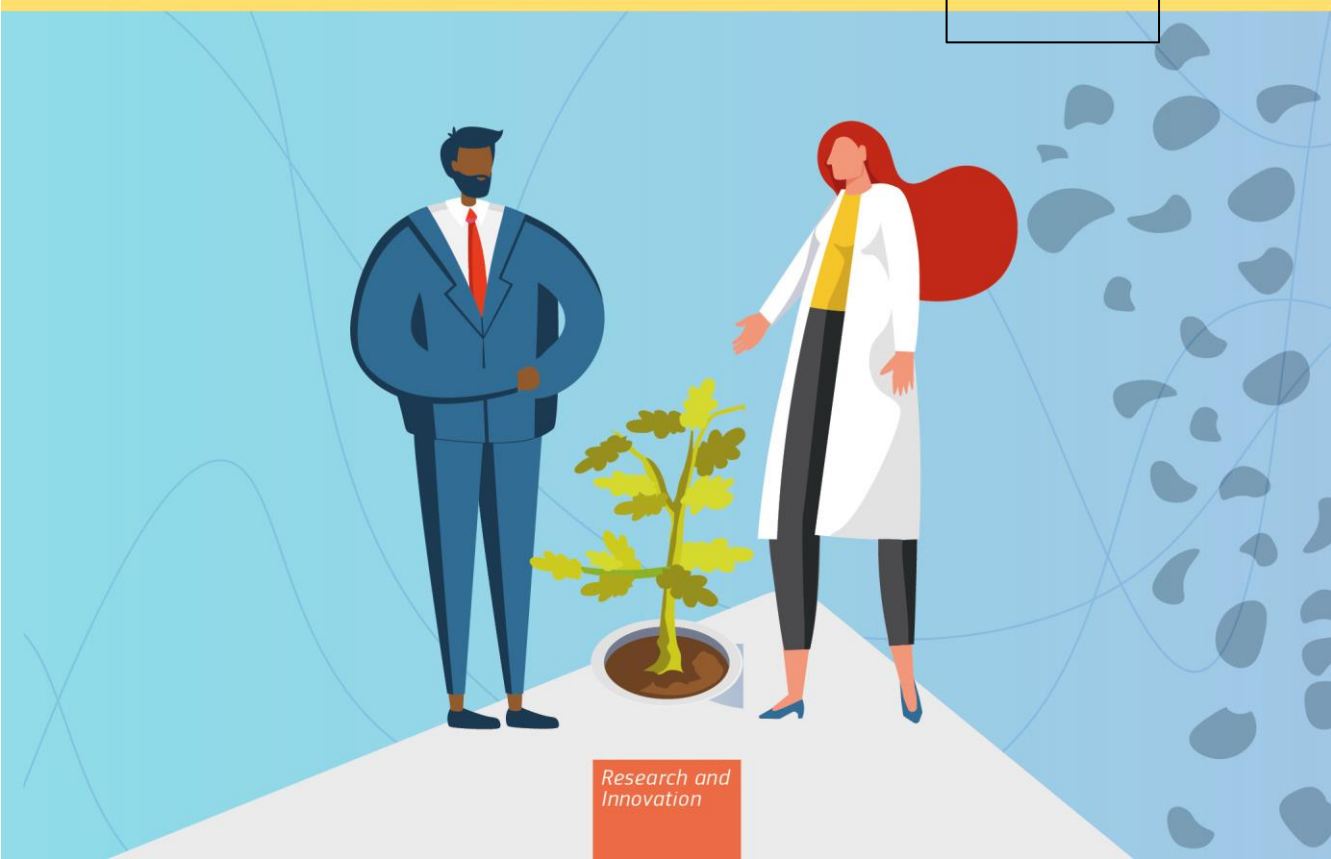

Research and Innovation

Scoping study for supporting the development of a code of practice for researchers on standardisation

European Commission
Directorate-General for Research and Innovation
Directorate E – Prosperity

Unit E.2 – Valorisation Policies and IPR

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EUROPEAN COMMISSION

Scoping study for supporting the development of a code of practice for researchers on standardisation

Final Report

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Directorate-General for Research and Innovation
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Abbreviations

3GPP	3rd Generation Partnership Project
5G	fifth-generation mobile communication technology
AB	advisory board
AM	additive manufacturing
ARCH hazards	Advancing resilience of historic areas against climate-related and other
ASTP	Association of European Science and Technology Transfer Professionals
BAM	German Federal Institute for Materials Research and Testing
CEN	European Committee for Standardisation
CENELEC	European Committee for Electrotechnical Standardisation
CNES	Centre national d'études spatiales
CSA	Community support action
CSP	concentrated solar power
CWA	European Committee for Standardisation workshop agreement
DED-Arc	directed energy deposition by wire arc
DG	Directorate-General
DIN	German Institute for Standardisation
DLT	distributed ledger technology
DMTF	Distributed Management Task Force
DSO	distribution system operators
EFFRA	European Factories of the Future Research Association
EFPF	European connected factory platform for agile manufacturing
EGNSS	European Global Navigation Satellite System
ELT	emergency locator transmitter
ELT-DT	emergency locator transmitter with distress tracking
ETSI	European Telecommunications Standards Institute
ETSI ENI	European Telecommunications Standards Institute Industry Specification Group on Experiential Networked Intelligence
ETSI INT	European Telecommunications Standards Institute Core Network and Interoperability Testing technical committee
ETSI PDL	European Telecommunications Standards Institute Industry Specification Group on Permissioned Distributed Ledgers
ETSI ZSM	European Telecommunications Standards Institute Industry Specification Group on Zero Touch Network and Service Management
EU	European Union

EUROCAE	European Organisation for Civil Aviation Equipment
FAIR	findability, accessibility, interoperability and reusability
FOSS	free and open-source software
GDP	gross domestic product
GDPR	general data protection regulation
H2020	Horizon 2020
HM	hybrid manufacturing
IA	innovation action
IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IHO	International Hydrographic Organization
IMO	International Maritime Organization
IoT	internet of things
IP	intellectual property
IPR	intellectual property rights
ISG	industry specification group
ISO	International Organization for Standardization
ITU	International Telecommunication Union
JRC	Joint Research Centre
KPI	key performance indicator
LEA	law enforcement agency
NGO	non-governmental organisation
NGS	next-generation sequencing
NGSO	non-geostationary satellite orbit
NMC	nickel–manganese–cobalt
NSB	national standards body
OASIS	Organization for the Advancement of Structured Information Standards
OGF	Open Grid Forum
PAS	publicly available specification
PPP	public–private partnership
PRO	public research organisation
R & D	research and development
R & I	research and innovation

RES	renewable energy sources
RI	research infrastructure
RIA	research and innovation action
RTCM	Radio Technical Commission for Maritime Services
SAR	search and rescue
SDO	standard-developing organisation
SEP	standard-essential patent
SMEs	small and medium-sized enterprises
SNIA	Storage Networking Industry Association
SynBio	synthetic biology
TC	technical committee
TRL	technology readiness level
TSO	transmission system operator
TTO	technology transfer office
UNE	Spanish Association for Standardisation
VIP	vacuum insulation panel
WG	working group
WP	work package
ZDM	zero-defect manufacturing

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ABSTRACT

This study aims to identify elements of good practice for researchers dealing with standards and standardisation in the course of research projects funded by Horizon 2020. The study involved (a) screening the replies to a European Commission survey sent to 2 200 beneficiaries of Horizon 2020 with evidence of standardisation activities (valid responses obtained from 1 020 projects with a 46 % return rate) and (b) applying a set of exclusion ('must have') and bonus point criteria, derived from targeted literature and expert interviews. We then selected 40 projects exhibiting a range of 'elements of good practice' for case study analysis, which identified any additional elements of good practice. Results indicate the existence of a stable and recurring set of elements of good practice. One important result is that the more exploratory research activities and the more formal standardisation processes are different in nature and difficult to synchronise. Standardisation activities within a research project largely lead to a need to engage in wider stakeholder management. There need to be close ties between the research consortia and the technical committees that develop standards. Researchers' awareness of and know-how about standardisation processes are frequently low, and the development of recognised performance indicators to track the success of technology transfer and valorisation activities is in its infancy. Recommendations were developed for universities / public research organisations (institutional level), researchers (project level), policymakers and the wider stakeholder community, and specifically regarding the development of performance indicators.

RÉSUMÉ

Cette étude vise à identifier les éléments de bonne pratique pour les chercheurs en charge des normes et de la normalisation dans le cadre de projets de recherche financés par Horizon 2020. L'étude a commencé par un examen des réponses à une enquête de la Commission européenne envoyée à 2200 bénéficiaires d'Horizon 2020 impliqués dans des activités de normalisation (des réponses exploitables ont été obtenues pour 1020 projets avec un taux de retour de 46%), puis par l'application de critères d'exclusion et de sélection, dérivés de la littérature ciblée et d'entretiens avec des experts. Sur cette base, nous avons sélectionné 40 projets présentant une série d'"éléments de bonnes pratiques" pour une analyse par étude de cas, qui a permis d'identifier de nouveaux éléments de bonne pratique. Les résultats indiquent l'existence d'un ensemble stable et récurrent d'éléments de bonnes pratiques. Un résultat important est que les activités de recherche et les processus de normalisation sont de nature différente et difficiles à synchroniser. Au sein d'un projet de recherche, les activités de normalisation nécessitent d'engager une gestion des parties prenantes : des liens étroits doivent être établis entre les consortiums de recherche et les comités techniques (CT) qui élaborent les normes. La sensibilisation aux processus de normalisation et le savoir-faire des chercheurs sont souvent faibles, et le développement d'indicateurs de performance reconnus pour suivre le succès des activités de transfert et de valorisation des technologies en est à ses débuts. Des recommandations ont été élaborées à l'intention des universités/organismes publics de recherche (OPR) (niveau institutionnel), des chercheurs (niveau du projet), des décideurs politiques et de l'ensemble des acteurs, notamment en ce qui concerne le développement d'indicateurs de performance.

EXECUTIVE SUMMARY

Background

- The present study is a 'scoping study for supporting the development of a code of practice for researchers on standardisation'. The study aims to identify elements of good practice for when researchers had to deal with standards and/or the process of standardisation in the course of research projects that were funded by Horizon 2020, the research and innovation framework programme of the EU for 2013–2020. The results and recommendations are to be used as inputs for the development of the code.
- Standards and standardisation have been increasingly recognised as an important channel for the successful transfer, commercialisation and valorisation of research results. They are hence an important factor contributing to innovation. Standards fulfil functions such as ensuring compatibility and interoperability between different products, or minimum quality and safety levels. They are also important for the creation of economies of scale and increasing efficiency in supply chains.
- However, this positive understanding of standards and standardisation is rather new, with the traditional view about the role that standards and standardisation play being more divided. As a result, (solid) know-how regarding the conscious use of standards and standardisation for the commercialisation and valorisation of knowledge is currently not widespread, and the body of literature and evidence assessing such practices in detail (including their monitoring and evaluation) has lagged considerably behind the evidence base for other commercialisation channels, such as the use of intellectual property (IP).
- This study aims to contribute to closing this gap. Methodologically, it does so by drawing on a targeted literature review, selected expert interviews and, most importantly, a survey conducted by the European Commission on Horizon 2020 projects dealing with standards/standardisation from 11 May 2021 to 15 June 2021. We used the survey – in conjunction with the literature and expert interviews – to single out projects that exhibit a broad range of elements of good practice when dealing with standards and standardisation. These projects were then each assessed in further detail, with interviews with project leaders, and then turned into case studies[1].

[1] For the selection of the case study projects, we developed a set of exclusion (or must-have) criteria to be eligible as a case study project, and, on top of that, a set of bonus criteria for certain identified elements of good practice. Overall, we created 40 case studies out of 1 020 responses to the survey (which was sent out to some 2 200 Horizon / framework programme projects, which would translate into a response rate of 46 %).

Results

The results of the study were as follows.

- Generally, all evidence sources, as well as the individual case studies, exhibited very similar and stable patterns concerning possible elements of good practice, with little contradictory evidence. Most elements of good practice concerned the preparation phase of research proposals. At the results/impact stages, we noted that the development and use of standardisation-specific key performance indicators are, however, in their infancy.
- The first and most important step when considering how to tackle standards and standardisation for a research project is to assess their relevance (i.e. whether there is a real need for standards or standardisation). As with other technology transfer channels, standards and standardisation are not a universal answer to every knowledge valorisation need. They should be used where viable and depending on the project context. Many projects among the case studies, upon realising that standardisation is in general a topic for them, performed a mapping of existing standardisation activities to understand these needs in detail, given that there can be a large number of such activities and that it is difficult to obtain a good overview.
- Another significant element of good practice is avoiding 'standards-washing' in research proposals. To counter this, an element of good practice is to have dedicated tasks and/or work packages for standards and standardisation, underpinned by adequate budgets, with clear responsibilities and outputs.
- The evidence collected clearly underlines that standardisation activities are in many respects different from research activities. Whereas research is more exploratory, standardisation follows considerably stricter processes with more clear-cut deadlines and formal requirements. Because the creation of a standard requires consensus among all participating entities (which can be very numerous), the time it takes to create a standard usually exceeds the running time of a Horizon project. In practical terms, this means that (a) it is usually difficult for a project to synchronise the research with the standardisation activities and (b) it is hardly possible to create a full standard as an output of a single Horizon project[2]. This has important ramifications for the design and management of standardisation activities in Horizon projects.
- One major ramification is that standardisation activities within a research project are largely associated with stakeholder management activities. The reason for that is the consensus-driven approach underpinning standardisation. In practice, this means that there is a need for negotiation skills, to foster and manage alliances; for the ability to push for one's own agenda while compromising on other issues that are important for other stakeholders; and, procedurally, for lengthy meetings (all this in addition to technical and

[2] A Horizon project refers to a Horizon 2020 project or Horizon Europe project.

linguistic skills, as the drafting of standards documents requires very precise language). Most importantly, there is a need to rally industry support, which requires corresponding marketing and outreach activities.

- Against this backdrop, another element of good practice for Horizon projects is to have project members in the consortia with (a) standardisation experience and (b) good links to the stakeholder community. Ideally, the research team should build stronger links with the technical committees working on a standard in order to be able to exert as much influence as possible on standardisation processes. Standard-developing organisations (SDOs) can in many instances be considered as potential project partners in a facilitating role, e.g. for creating standardisation gap analyses, identifying and reaching out to technical committees, or training consortium members on standardisation activities. Many SDOs (but not all) provide these services.
- The issue of different timescales for standardisation and research projects can be tackled in several ways. One way is to have, if possible, a string of consecutive Horizon projects spanning over several years. The project portfolio can hence cater for fully fledged standardisation processes. SDOs have also created 'standards-light'-like instruments (e.g. reference specifications such as European Committee for Standardisation workshop agreements (CWAs) and German Institute for Standardisation specifications), which do not require full stakeholder consensus and can be developed within the lifetime of a single Horizon project. However, these instruments also have downsides. It is also possible to aim only to contribute to the development of standards. That way the timing issues are acknowledged and the inputs to standards development can be still provided.
- Overall, the results indicate that sustainability of the project results and of the standardisation that have been achieved beyond the running time of a Horizon project is a significant element of good practice. CWAs and similar instruments can be one way of realising this element of good practice, as they are published by their SDOs and hence made accessible to the standardisation stakeholder community for a long time. Ensuring sufficient industry support is another way to ensure sustainability, so that existing industry players themselves (or, alternatively, spin-offs/start-ups) take the standardisation-related project results further.
- The study has also revealed, based on several project case studies, the need to align the standardisation activities with IP management. There may be significant overlaps with IP instruments such as patents (where questions may arise with respect to standard-essential patents, their identification and licensing); copyrights (particularly in connection with open-source software and licensing models); and trade secrets. This last was an intriguing observation in several project case studies. The issue is that standardisation requires dissemination and publication of information so that other parties can use a standard. Contrary to that, as their very name indicates, trade secrets require that information remain confidential. This naturally creates tensions and calls for very fine-

tuned and synchronised IP management if, for example, the business model of a start-up/spin-off relies on trade secrets.

- Finally, the general strategic element of standardisation should not be forgotten as an important success factor for the valorisation of the research and innovation results in Horizon or other publicly funded research projects. We define 'general strategic elements' as framework conditions beyond the control of research projects. One such major issue is the lack of consideration given by research organisations and universities to the standardisation activities of their researchers (which do not usually count towards career assessments and progression). A similar issue is the general lack of knowledge about standardisation, prompting the need for training and awareness-raising activities. Without incentives and a good framework for pre-normative research to engage in standardisation, Europe faces the risk of falling behind its global competitors in standard setting, especially at a time when these economies – most notably China – are investing heavily in the creation of standards.

Recommendations

Against the backdrop of the analysis above, we developed a series of recommendations. These are (full details to be found in Chapter 4 of the main report):

A. Recommendations for universities and public research organisations – institutional level:

- Recommendation A1: Develop a standardisation policy, alongside or as part of an IP or research and development (R & D) results valorisation policy
- Recommendation A2: Consider standardisation activities and outputs appropriately in the career development plans and research assessment exercises of researchers
- Recommendation A3: Provide for training and teaching on standardisation
- Recommendation A4: Make technology transfer offices fit for standardisation
- Recommendation A5: Develop an indicator and evaluation system

B. Recommendations for researchers (project level):

- Recommendation B1: Assess carefully whether and where standards and/or standardisation are really needed in the research project
- Recommendation B2: Create a common understanding (i.e. basic knowledge), as well as a common strategic position in the consortium, on standardisation and standardisation issues
- Recommendation B3: Make standards a tangible component in the proposal and project
- Recommendation B4: Involve partners with standardisation experience in the team, with good access to the standardisation community

- Recommendation B5: Invest in and cater for stakeholder management throughout the project
- Recommendation B6: Be realistic about outputs, outcomes and impacts – consider appropriate key performance indicators
- Recommendation B7: Take standardisation issues into account in IP management and strategy (and vice versa)
- Recommendation B8: Ensure sustainability beyond the running time of the project

C. Recommendations at policy / wider stakeholder levels:

- Recommendation C1: Have the European Commission engage with SDOs and (European) university associations as well as associations of technology transfer offices (e.g. the Association of European Science and Technology Transfer Professionals)
- Recommendation C2: Have SDOs further develop their service portfolios for R & D projects and examine further possibilities to synchronise standardisation with R & D better
- Recommendation C3: Examine, in particular, small and medium-sized enterprises' needs in collaborative research in relation to standards and standardisation
- Recommendation C4: Address the Member State policy level and national Horizon support structures

D. Recommendations specifically regarding indicators:

- Recommendation D1: Push for the development of an evidence base regarding viable sets of indicators to be used for performance assessment of R & D in relation to standardisation activities
- Recommendation D2: Strive for combined qualitative and quantitative performance reporting for evaluations and monitoring

SOMMAIRE EXÉCUTIF

Contexte

- L'étude est une "étude exploratoire pour soutenir le développement d'un "Code de pratique" pour les chercheurs sur la normalisation". L'étude vise à identifier les éléments de bonne pratique pour les chercheurs abordant des normes et/ou des processus de normalisation au cours de projets de recherche financés par Horizon 2020, le programme-cadre de recherche et d'innovation de l'UE pour la période 2013-2020. Les résultats et les recommandations serviront de base pour l'élaboration du code.
- Les normes et la normalisation sont de plus en plus reconnus comme un facteur important pour le transfert, la commercialisation et la valorisation des résultats de la recherche. Elles constituent donc un élément important de l'innovation. Les normes assurent différentes fonctions, telles que garantir la compatibilité et l'interopérabilité entre différents produits ou des niveaux minimaux de qualité et de sécurité. Elles sont également importantes pour la création d'économies d'échelle et de gains d'efficacité dans des chaînes d'approvisionnement.
- Toutefois, cette vision des normes et de la normalisation est plutôt nouvelle, la conception traditionnelle du rôle joué par les normes et la normalisation étant plus fragmentée. En conséquence, le savoir-faire concernant l'utilisation des normes et de la normalisation pour la commercialisation et la valorisation des connaissances n'est actuellement pas très répandu, et le corpus respectif de littérature et de preuves évaluant ces pratiques (y compris leur suivi et leur évaluation) a pris un retard considérable par rapport à la base de preuves pour d'autres canaux de commercialisation, tels que l'utilisation de la propriété intellectuelle (PI).
- Cette étude vise à contribuer à combler cette lacune. Sur le plan méthodologique, elle s'appuie sur une revue de la littérature, des entretiens avec des experts et, surtout, une enquête menée par la Commission européenne (CE) auprès de projets Horizon 2020 traitant des normes/de la normalisation, entre le 11 mai 2021 et 15 juin 2021. Nous avons utilisé l'enquête - en conjonction avec la littérature et les interviews d'experts - pour repérer les projets qui présentent un large éventail d'éléments de bonnes pratiques en matière de normes et de standardisation. Ces projets ont ensuite été évalués de manière plus détaillée au moyen d'entretiens avec les chefs de projet, puis transformés en études de cas.

Résultats

Les résultats de l'étude sont les suivants :

- D'une manière générale, tous les éléments de preuves, ainsi que les études de cas individuelles, présentaient des schémas similaires et stables concernant les éléments possibles de bonne pratique, avec peu de preuves contradictoires. La plupart des éléments de bonne pratique concernaient la phase de préparation des propositions de

recherche. Cependant, aux stades des résultats et de l'impact, nous avons constaté que le développement et l'utilisation d'indicateurs clés de performance spécifiques à la normalisation n'en sont qu'à leurs débuts.

- La première étape, et la plus importante, lorsqu'on s'interroge sur la manière d'aborder les normes et la normalisation pour un projet de recherche, est d'évaluer la pertinence (c'est-à-dire de déterminer le besoin de normes ou de normalisation). Comme avec d'autres canaux de transfert de technologie, les normes et la normalisation ne sont pas une réponse universelle à tous les besoins de valorisation des connaissances. Il convient donc de bien tenir compte du contexte du projet pour comprendre ces besoins en détail. La normalisation étant en général un sujet pertinent pour les projets, les nombreuses études de cas de projets déjà réalisées constituent une cartographie des activités de normalisation existantes qui donne une bonne vue d'ensemble.
- Un autre élément important de bonne pratique consiste à éviter le "lavage de normes" dans les propositions de recherche. Pour contrer ce phénomène, un élément de bonne pratique est de prévoir des tâches et/ou des modules de travail dédiés aux normes et à la normalisation, étayé par des budgets suffisants, et des responsabilités et des résultats clairement définis.
- Les données recueillies soulignent nettement que les activités de normalisation diffèrent des activités de recherche, à de nombreux égards. Alors que la recherche est plus exploratoire, la normalisation suit des processus plus stricts, des délais précis et des exigences formelles. La création d'une norme nécessite un consensus absolu entre les entités participantes (et le nombre d'acteurs concernés peut être très important), dès lors le temps nécessaire à la création d'une norme dépasse généralement la durée d'un projet Horizon. Concrètement, cela signifie que, a) il est généralement difficile de synchroniser un projet de recherche avec les activités de normalisation et b) il est difficile de créer une norme complète comme résultat d'un projet Horizon. Cela a des répercussions importantes dans la conception et la gestion des activités de normalisation au sein de projets Horizon 2020.
- Une répercussion majeure est que les activités de normalisation au sein d'un projet de recherche sont largement associées à la gestion des parties prenantes. En effet, l'approche consensuelle caractérise la normalisation. En pratique, des compétences en matière de négociation sont nécessaire afin d'encourager et de gérer les alliances, de promouvoir son propre programme tout en faisant des compromis sur d'autres questions importantes pour les parties prenantes et, sur le plan de la procédure, de tenir de longues réunions (tout cela en plus des compétences techniques et linguistiques, car la rédaction des documents de normalisation exige un langage très précis). Surtout, il est nécessaire de rallier le soutien de l'industrie, ce qui exige des activités respectives de marketing et de sensibilisation.
- Dans ce contexte, un autre élément de bonne pratique pour les projets Horizon est d'inclure dans les consortiums des membres avec a) une expérience de la normalisation

et b) des liens solides avec la communauté des parties prenantes. Idéalement, l'équipe de recherche devrait établir des liens plus étroits avec les Comités Techniques (CT) travaillant sur une norme afin d'être en mesure d'exercer une plus grande influence sur les processus de normalisation. Dans de nombreux cas, les Organismes De Normalisation (ODN) peuvent être considérés comme des partenaires de projet potentiels jouant un rôle de facilitateur, par exemple pour la création d'analyses des écarts relatifs à la normalisation, l'identification et la prise de contact avec les CT, ou la formation des membres du consortium aux activités de normalisation. En fait, de nombreux ODN (mais pas tous) offrent ces services.

- La question des différentes temporalités entre la normalisation et les projets de recherche peut être abordée de plusieurs manières. L'une d'elles consiste à mettre en place une série de projets Horizon consécutifs s'étendant sur plusieurs années. Le portefeuille de projets peut ainsi couvrir des processus de normalisation dans leur totalité. Les ODN ont également créé des instruments de type "normes légères" (par exemple, des spécifications de référence comme les CEN Workshop Agreements (CWA), les DIN Specs, etc.) qui ne nécessitent pas un consensus absolu des parties prenantes et peuvent être développés pendant la durée de vie d'un seul projet Horizon. Toutefois, ces instruments présentent également des inconvénients. D'autre part, il est possible de viser uniquement les contributions à l'élaboration de normes. De cette façon, les problèmes de temporalités sont reconnus et les contributions à l'élaboration de normes peuvent être apportées.
- Dans l'ensemble, les résultats indiquent que la durabilité des résultats du projet et de normalisation obtenue au-delà de la durée de vie d'un projet Horizon est un élément important des bonnes pratiques. Les CWA et les instruments similaires peuvent être un outil pour mettre en œuvre cet élément de bonne pratique, car ils sont publiés par leurs ODN et donc accessibles à la communauté des parties prenantes de la normalisation pendant des périodes prolongées. Garantir un soutien suffisant de l'industrie est un autre moyen d'assurer la durabilité, de sorte que les acteurs industriels existants (ou alternativement, les spin-offs/start-ups) exploitent davantage les résultats des projets liés à la normalisation.
- L'étude a également mis en évidence, sur la base de plusieurs études de cas de projets, la nécessité d'aligner les activités de normalisation sur la gestion de la Propriété Intellectuelle (PI). On peut observer des similitudes avec des instruments de PI tels que les brevets (où des questions peuvent se poser en ce qui concerne les brevets "standard-essential patents" (SEPs), leur identification et l'octroi de licences) ; les droits d'auteur (en particulier en relation avec les logiciels libres et les modèles de licence) ; et les secrets commerciaux. Ce dernier point a été une observation intéressante dans plusieurs études de cas. En effet, la normalisation nécessite la diffusion et la publication d'informations afin que d'autres parties puissent en bénéficier. À l'inverse, les secrets commerciaux, par leur nom même, exigent que les informations restent confidentielles. Cela crée naturellement des tensions et exige une gestion très fine et synchronisée de

la PI si, par exemple, le modèle commercial d'une start-up/spin-off repose sur des secrets commerciaux.

- Enfin, il ne faut pas perdre de vue que l'élément stratégique général de la normalisation est un facteur de réussite important pour la valorisation des résultats de la R&I dans les projets de recherche Horizon ou d'autres projets de recherche à financement public. Nous définissons les "éléments stratégiques généraux" comme des conditions cadres échappant au contrôle des projets de recherche. Le manque de considération accordée par les organismes de recherche et les universités aux activités de normalisation de leurs chercheurs (qui ne comptent généralement pas dans l'évaluation et la progression de leur carrière) est l'un des principaux problèmes. Il existe un besoin de formation et de sensibilisation en raison de la méconnaissance de la normalisation. Sans incitations et sans un bon cadre pour que la recherche prénormative s'engage dans la normalisation, l'Europe risque de prendre du retard par rapport à ses concurrents mondiaux en matière de normalisation, surtout à un moment où ces économies - notamment la Chine - investissent massivement dans la création de normes.

Recommandations

À partir de l'analyse présentée ci-dessus, nous avons élaboré une série de recommandations (dont le texte complet figure au chapitre 4 du rapport principal) :

A. Recommandations pour les universités et les organismes publics de recherche (OPR) - niveau institutionnel

- Recommandation A1: développer une politique de normalisation, parallèlement ou dans le cadre d'une politique de valorisation de la PI ou des résultats de la R&D.
- Recommandation A2: prendre en compte de manière appropriée les activités et les résultats de la normalisation dans les plans de développement de carrière et les exercices d'évaluation de la recherche des chercheurs.
- Recommandation A3: Offrir une formation et un enseignement sur la normalisation.
- Recommandation A4: Adapter les bureaux de transfert de technologie (BTT) à la normalisation.
- Recommandation A5: Développer un système d'indicateurs et d'évaluation.

B. Recommandations pour les chercheurs (au niveau des projets)

- Recommandation B1: Évaluer soigneusement les besoins réels en matière de normes et/ou de normalisation dans le cadre du projet de recherche.
- Recommandation B2: Créer une approche commune, c'est-à-dire des connaissances fondamentales et une position stratégique commune au sein du consortium sur la normalisation et les questions de normalisation.

- Recommandation B3: faire des normes un élément tangible de la proposition du projet, et du projet lui-même.
- Recommandation B4: Associer à l'équipe des partenaires ayant une expérience de la normalisation et disposant de liens étroits avec la communauté des normalistes.
- Recommandation B5: Investir et veiller à la gestion des parties prenantes tout au long du projet.
- Recommandation B6: Viser des résultats, des réalisations et des effets réalistes. - des indicateurs clés de performance adéquats doivent être envisagés.

C. Recommandations au niveau politique / des parties prenantes plus larges

- Recommandation C1: La CE doit s'engager auprès des ODN et des associations universitaires (européennes) ainsi que des associations de bureaux de transfert de technologie (Association des professionnels européens du transfert des sciences et technologies).
- Recommandation C2: les ODN doivent continuer à développer leurs portefeuilles de services pour les projets de R&D et examiner d'autres possibilités pour mieux concilier la normalisation et la R&D.
- Recommandation C3: examiner en particulier les besoins des PME en matière de recherche collaborative en relation avec les normes et la normalisation.
- Recommandation C4: Prise en compte des politiques nationales des Etats Membres et des structures de soutien nationales Horizon.

D. Recommandations concernant spécifiquement les indicateurs

- Recommandation D1: Encourager le développement d'une base de données probantes concernant des ensembles viables d'indicateurs à utiliser pour l'évaluation des performances de la R&D en relation avec les activités de normalisation.
- Recommandation D2: Viser une approche combinée des rapports de performance qualitatifs et quantitatifs pour les évaluations et le suivi.

INTRODUCTION

PURPOSE OF THE STUDY

This is the final report for the project 'Scoping study for supporting the development of a code of practice for researchers on standardisation'. The study seeks to understand how the topic of standards and standardisation should be catered for in research projects. It aims to formulate recommendations for three major target groups: foremost researchers, then universities and public research organisations (PROs) and, finally, other relevant stakeholders. There are also recommendations regarding indicator development. These recommendations should feed into an upcoming code of practice for researchers on standardisation in the European Commission that aims to guide beneficiaries of public research and innovation (R & I) programmes to best identify opportunities and techniques to valorise their project results through standardisation.

Scope of the study

The study examines, in particular, the use of standards and standardisation in Horizon 2020 projects. To this end, a methodology has been developed to single out 40 projects as case studies that deal with standards and standardisation in good ways, and hence exhibit different elements of good practice. The basis for the selection was a survey carried out by the European Commission to identify projects that deal with standards and standardisation and to enquire about the ways in which standards and standardisation have been catered for. The survey, while extensive, was mainly used in this study to narrow down and select the cases that were then the subject of case study analyses.

Overall, the report is structured as follows:

- Section 1 (this section) is a brief introduction to the study topic;
- Section 2 provides some background to the policy field;
- Section 3 presents the main results of the analysis;
- Section 4 outlines a set of recommendations for the use of standardisation as a means of R & I valorisation;
- Section 5 provides final concluding remarks.

BACKGROUND TO THE POLICY FIELD

Standardisation as means of research and innovation valorisation

The project is set against the backdrop of an increasing understanding in innovation policy over the last two decades, which shows that innovation success, particularly in today´s globalised world, is not only the result of providing money for research and development (R & D). Rather, innovation success depends on the interplay of various instruments, including – besides availability of finance – the context-specific management of intellectual property (IP) rights, the conscious opening up of innovation processes, and engagement in

partnerships with various organisations and market players (open innovation), in addition to, for example, regulatory measures or innovation procurement. This understanding correlates with an increasing interest in assessing the specific roles, success factors and challenges for navigating and leveraging these instruments that have been traditionally at the fringes of the attention of innovation researchers and policymakers.

One such field that was until recently at the fringes is standards and standardisation ([3]). Traditionally believed to be a side issue inhibiting and slowing down innovation, the field has seen an ever-increasing number of papers and thought pieces published over the last 20 years. Today, the prevailing understanding among scholars and experts is that standards and standardisation, done the right way, spur innovation and contribute significantly to the mastering of environmental, safety or health challenges. Studies have attempted to put a figure on the contribution of standards and standardisation to gross domestic product (GDP) and estimated they may account for as much as 0.72 % of GDP (in the case of Germany) ([4]). A key factor in such macroeconomic studies is the (well-argued) assumption in the modelling that standards and standardisation are a means of disseminating knowledge, i.e. a channel of technology and knowledge transfer that picks up on R & D outputs such as patents or publications. While patents show what kinds of inventions have been created, standards, when successfully implemented, ensure the uptake and wider use of these inventions by, for example, guaranteeing interoperability and compatibility, and minimum quality and safety levels, or by codifying knowledge in clear and specific ways.

However, to date, standards and standardisation have barely entered the discussion on effective and efficient technology transfer between science and industry. The discussion still centres very much on knowledge channels that involve either patenting and licensing to commercialise R & D results or, as an alternative, IP-free forms of 'academic engagement' with industry ([5]). These views are also still reflected in many current pieces of research for the European Commission. For example, the expert group report *Knowledge Transfer Metrics* of 2020 ([6]) discusses a multitude of knowledge transfer indicators but does not mention standards or standardisation even once. This is in line with the still current Commission recommendation on the management of intellectual property in knowledge transfer activities and code of practice for universities and other public research organisations of 2008 ([7]), which also does not tackle standards or standardisation; and with the work done to assess impact pathways for Horizon Europe projects ([8]).

([3]) Radauer, A. (2020), 'Driving from the fringe into spotlight – the underrated role of standards and standardization in RTDI policy and evaluation, *fteval Journal for Research and Technology Policy Evaluation*, Vol. 51, pp. 59-65.

([4]) Blind, K., Jungmittag, A. and Mangelsdorf, A. (2012), *The Economic Benefits of Standardisation – An update of the study carried out by DIN in 2000*. https://www.researchgate.net/publication/255869222_The_economic_benefits_of_standardisation_An_update_of_the_study_carried_out_by_DIN_in_2000

([5]) Perkmann, M., Tartari, V., Mckelvey, M., Autio, E., Broström, A., D'Este, P., Fini, R., Geuna, A., Grimaldi, Hughes, A., Krabel, S., Kitson, M., Llerena, P., Lissoni, F., Salter, A. and Sobrero, M. (2013), 'Academic engagement and commercialisation: a review of the literature on university–industry relations', *Research Policy*, Vol. 42, No 2, pp. 423–442; Bekkers, R. and Bodas Freitas, I.-M. (2008), 'Analysing knowledge transfer channels between universities and industry: to what degree do sectors also matter?', *Research Policy*, Vol. 37, pp. 1837–1853. However, it can be argued that the view of Perkmann et al. is too simplistic because many channels that seem to be IP-free forms of academic engagement still run on the basis of some sorts of IP agreements when examined in more detail.

([6]) Campbell, A., Cavalade, C., Haunold, C., Karanikic, P., Piccaluga, A. and Dinnetz, M. (2020), *Knowledge Transfer Metrics: Towards a European-wide set of harmonised indicators*, European Commission, JRC.

([7]) European Commission (2008), Commission recommendation on the management of intellectual property in knowledge transfer activities and Code of Practice for universities and other public research organisations (https://op.europa.eu/en/publication-detail/-/publication/743a513c-e1ab-455e-a2f2-20ef43c3060e).

([8]) Bruno, N. and Kadunc, M. (2019), 'Impact pathways: tracking and communicating the impact of the European Framework Programme for research and innovation', *fteval Journal for Research and Technology Policy Evaluation*, Vol. 47, pp. 62–71.

In a departure from this tradition, the Commission staff working document 'A new ERA for research and innovation' states that 'standardisation, based on robust research results, facilitates the access to and spreading of new products in the market' and calls for standardisation 'to be better recognised as a tool to valorise R & I results to make sure that the European standardisation system is an integral part of the European research and innovation landscape' ([9]). Similarly, a policy review on 'valorisation channels and tools' by the Directorate-General (DG) for Research and Innovation put standards together with IP as one important channel for technology transfer. It states:

> *Standardisation must be considered during the research and should not be seen as a technicality reserved for large companies. To disseminate, codify and facilitate the valorisation of R & I results, there is a need to educate and advise the research community on understanding and thinking about standardisation from the early stages of the research. Awareness-raising campaigns on the importance of standardisation are key for knowledge creators, including researchers and small businesses* ([10]).

The problem in question, however, is that the body of evidence showing how standards and standardisation can underpin research projects and lead to improved ways to commercialise R & D results and create wider impacts is still only in development.. Projects such as Bridgit and Bridgit 2 ([11]) have been milestones in this regard, but there is still a need to better, and more granularly, understand the do's and don'ts of considering standards and standardisation in Horizon projects.

An example of this need for more evidence is the underdeveloped topic of indicator development for monitoring knowledge and technology transfer by means of standards and standardisation. Evidence is needed to inform a specific recommendation / code of practice for researchers that the European Commission intends to develop together with stakeholders.

The present study hence aims to provide two things.

- **An evidence base.** Based on the analyses of publicly available literature and a set of 40 selected Horizon 2020 (H2020) projects that have used standardisation to valorise R & I results, it creates an evidence base to help understand success factors of funded collaborative research projects in relation to the valorisation of their results thanks to involvement in standardisation activities.

- **A set of recommendations.** The study provides a set of recommendations on how beneficiaries of public R & I funds can best valorise project results through standardisation. These recommendations are based on the analyses of the examples of H2020 projects and the lessons learnt from them, identifying areas for improvement that serve as a basis for concrete actions for future beneficiaries.

([9]) European Commission (2020), Commission communication – A new ERA for research and innovation (COM(2020) 628 final), pp. 58 and 62.

([10]) European Commission (2020), *Valorisation Channels and Tools – Boosting the transformation of knowledge into new sustainable solutions* (https://op.europa.eu/en/web/eu-law-and-publications/publication-detail/-/publication/f35fded6-bc0b-11ea-811c-01aa75ed71a1).

([11]) https://www.din.de/en/innovation-and-research/research-projects/innovation-and-education/bridgit2-276692

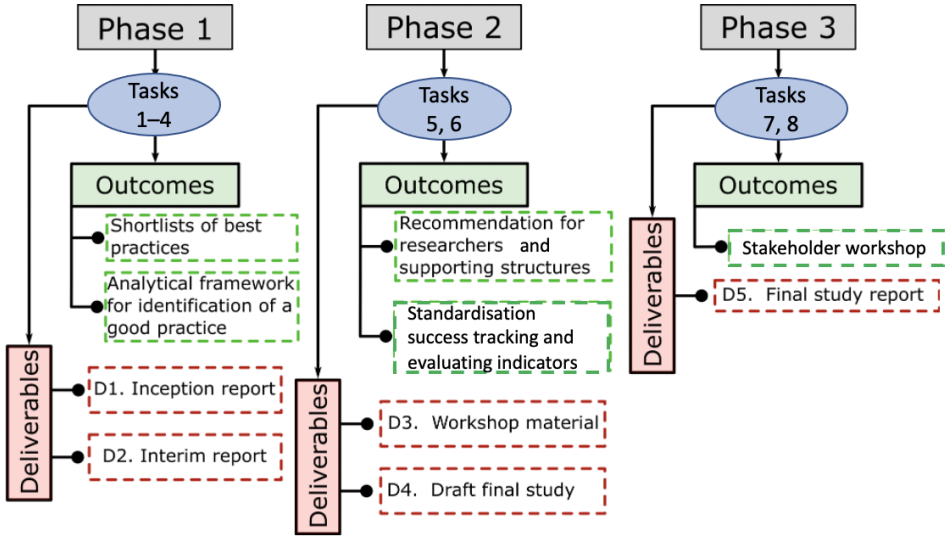
Methodology and best practice selection

In this section, we provide an overview of the methodology employed. A more detailed description of the methodology is found in Annex 2.

The methodology was employed in three different phases:

- the main objective of the phase 1 analysis in this study was to discover examples of projects exhibiting different elements of good practice out of a large number of projects from the abovementioned European Commission survey, as shown in Figure 1;
- the objective of phase 2 was to derive recommendations, single out success factors and challenges, and finally develop indicators for tracking/evaluating standardisation use in Horizon projects;
- phase 3 was devoted to putting the results to test and discussion in a stakeholder workshop and to creating the final study report.

Figure 1 General view of the study structure



Source: Study team.

Overall, the study team followed the following process for selecting and analysing case studies.

- In a first step (1), we used a general four-tier framework to sort possible elements of good practice (hereafter also colour-coded). We distinguished between project history/conceptualisation (i.e. everything that happened prior to approval of funding in the proposal preparation phase), the experiences while implementing the projects once a funding decision was reached, the results and impacts achieved by the projects, and general success factors.

- In a second step (2), we aimed to identify the most likely elements of good practice for the use of standards and standardisation in funded research projects by

analysing the literature in the course of a targeted literature review, interviewing a select number of experts, and referring to projects and their descriptions that received at least a nomination in the European Committee for Standardisation and European Committee for Electrotechnical Standardisation (CEN-CENELEC) awards (based on the assumption that only reasonably well-performing projects would be nominated for such an award).

- In a third step (3), the elements of good practice deduced from step 2 were sorted into the framework of step 1 and used as a first set of selection criteria to identify cases that exhibit elements of good practice.

- Then the success criteria found were compared with the questions in the European Commission survey, with the major consideration being what questions in the survey correspond to an element of good practice and can be used for singling out projects for further analysis. To this end, the survey questions were categorised according to the segments of the four-tier empirical framework (4) and then matched with the deduced success criteria (5).

- By applying these success criteria to the dataset, a pre-selection of best practice cases was found (6). We did this using a twofold approach. We first defined a set of criteria as must-haves: if projects did not exhibit these features, they would not be considered for further analysis. Of those projects that survived the pre-selection, we awarded bonus points for several criteria that were not must-haves but desirable features judging from the previously collected evidence. For each of these criteria, bonus points could be obtained. This resulted in a ranking of projects, of which the 40 highest ranked were finally selected for the qualitative case study analysis.

- After the 40 cases were identified, interviews with project leaders and further data analyses were employed to better understand the special characteristics of these projects so others could learn from their experiences (7). Using a feedback loop (8) – such as via the stakeholder workshop shown in Figure 1 – helped to refine the success factors and elements of good practices. These finally informed the recommendations provided.

It should be underlined that the selection methodology as described above has limitations insofar as it cannot provide for an objective ranking of projects as best practices. We argue that such a best practice list is not possible due to the very different contexts the projects operate in. We therefore dropped the notion of best practices and reverted to the notion of projects exhibiting different elements of good practice.

Along the same lines, while the selection methodology would in principle provide for a detailed ranking list of projects (including among the top 40 projects), we refrained from using such a detailed ranking altogether. This was done for the following reasons.

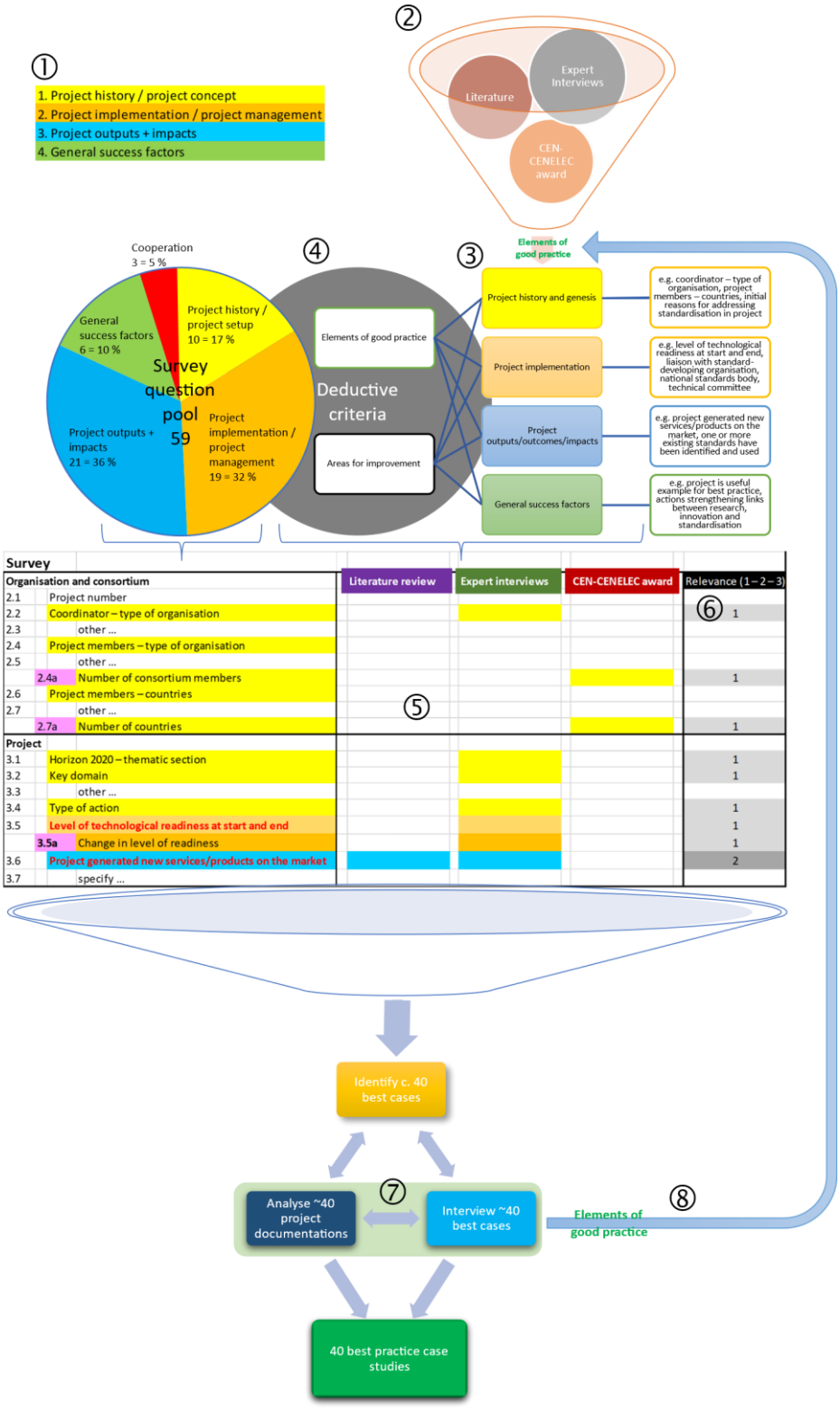
- Not being part of the 40 selected case study projects does not exclude the possibility that projects could still perform well in terms of standardisation activities. For example, the methodology used had, for practical reasons, the must-have criterion of a positive reply from survey respondents that they would support the study team when elaborating the case studies (i.e. projects were excluded for further scrutiny if they would not support us with, for example, an additional interview). Nonetheless, ‘unwilling’ projects could still fare well in relation to standardisation activities.

- Another case in point is projects that perform very well on a single criterion (or very few criteria), but do not fulfil other criteria that are not relevant in the specific context of the project. The specific projects contexts are difficult to capture and to assess objectively against each other. This implies that a detailed ranking list would suggest a level of measurement precision that may not reflect reality.

The selection methodology is in our view, however, sufficient for the purpose of broadly singling out interesting project case study examples for further analysis. The methodology should be hence understood to have meant to identify only projects with (a) a relatively high likelihood of observing a certain breadth of elements of good practice and (b) observed elements of good practice that reflect the results of the literature review and the scoping interviews with experts in terms of scope and importance assigned to good practice elements.

Having said that, it is noteworthy that the sensitivity analysis applied to test for different combinations of must-have and desirable elements of good practices showed that, for the most part, the selected set of cases remained similar across a variety of different selection criteria / elements of good practice. The process for selecting and analysing case studies is depicted in Figure 2.

Figure 2 Overall approach to identifying case studies exhibitg elements of good practice



Survey			Literature review	Expert interviews	CEN-CENELEC award	Relevance (1 – 2 – 3)
Organisation and consortium						
2.1		Project number				
2.2		Coordinator – type of organisation				1
2.3		other …				
2.4		Project members – type of organisation				
2.5		other …				
	2.4a	Number of consortium members				1
2.6		Project members – countries				
2.7		other …				
	2.7a	Number of countries				1
Project						
3.1		Horizon 2020 – thematic section				1
3.2		Key domain				1
3.3		other …				
3.4		Type of action				1
3.5		Level of technological readiness at start and end				1
	3.5a	Change in level of readiness				1
3.6		Project generated new services/products on the market				2
3.7		specify …				

Source: Study team.

MAIN FINDINGS OF THE ANALYSIS

European Commission survey characteristics

The European Commission survey ran from 11 May 2021 to 15 June 2021. It was sent out to 2 200 project beneficiaries (unit of analysis: projects), and 1 020 replied. This equated to a response rate of 46 %, which is considerably higher (by a factor of 3 or more) than the study team foresaw in the technical offer.

3.1.1. Step 1: data validation

The survey data were provided to us in Excel format. The raw data were tentatively cleaned up in an Excel document and prepared for migration to the SPSS software package.

In the first step, we familiarised ourselves with the existing data. To accurately export the survey data from Excel to SPSS for further procession and analysis, we gave numerical values to closed questions and split them into separate columns. The data were screened and we looked for irregularities. The systematic use of zero ('0') was recoded as 'No' in the relevant places.

In addition, we cleaned the raw data in the Excel document to get rid of, for example, technical misprints and wrong, inconsistent values, and fixed structural errors. Most of the answers to open-ended questions were preliminarily screened, grouped and coded applying the flat coding frame.

The deeper data check did not find any missing data. For this reason, there was no formal necessity to exclude data records. However, a later check of the content revealed minor discrepancies, and these data records were eliminated (e.g. technology readiness levels (TRLs)[12]; some project managers confused starting point and end point data).

There are 14 duplicate entries with the same project numbers. In most cases, a negative self-assessment of the project's success by its members already eliminates this project from further use. If multiple entries put in (nearly) the same data, the use of the data is possible if a contact person is given. Only entries with contradictory contents have been removed from the dataset.

To obtain more detailed information from the data, some open questions were coded. However, data also needed to be summarised to a higher granularity (e.g. liaison with standardisation bodies). Some simple closed questions were converted to metric data (e.g. calculation of the change in the TRL) to allow for further interpretation.

3.1.2. Step 2: exploratory analysis of responses – overview of key results

([12]) https://ec.europa.eu/research/participants/data/ref/h2020/wp/2014_2015/annexes/h2020-wp1415-annex-g-trl_en.pdf

The survey was composed of 55 questions in total, with open-ended and closed questions grouped into eight thematic blocks:

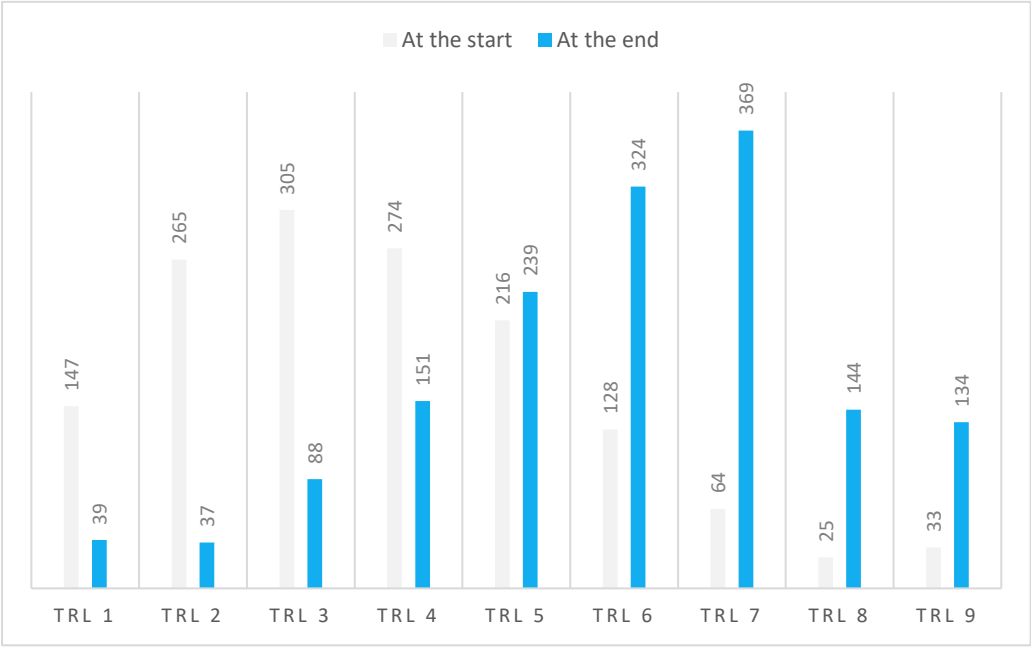
1. introduction
2. organisation and consortium-related information
3. project-specific information
4. information about liaison with standard-developing organisations (SDOs)
5. addressing standardisation in the project
6. project contribution to existing standards
7. project contribution to the development of new and/or revision of existing standards
8. relevance of the project in terms of being a best practice case.

The most noteworthy of the answers to the questions in the second and third thematic blocks are those related to the TRL at the project start/end. The most common replies mentioned TRL 3 at the outset of the project (more than 305 projects) and TRL 7 at the end (369 projects), as shown in

Figure 3.

As will also be discussed later, the TRLs (and the change therein during the project) can be considered an important indicator for assessing the relevance and performance of an R & D project in terms of (among others) the standardisation activities. Different TRLs may also imply different needs in terms of standards and standardisation: lower TRLs are associated more with work to be done, e.g. on terminologies, while later-stage TRLs are more concerned with issues such as interoperability of the technology/innovation – hence, standards can also be important for lower-level TRLs (see also Section 3.3.3).

Figure 3 Level of technology readiness at the start and at the end of the projects

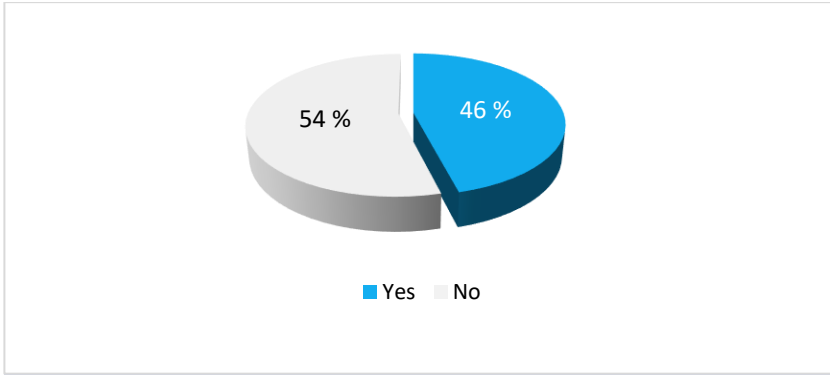


Source: Survey question 3.5 'Which level of readiness describes your technology at the start and at the end of your project?'

Another important statistic refers to the new services and/or products deployed to the market during or beyond the end of the project. As seen from **Error! Reference source not found.**, t

he balance between negative and positive answers is insignificant, slightly in favour of negative ones.

Figure 4 Delivery of new services and/or products during/beyond the project end date

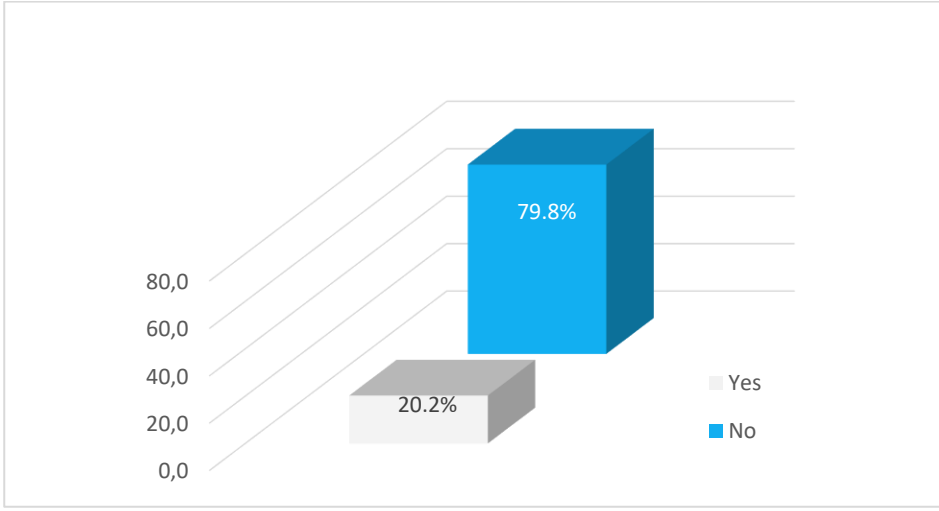


Source: Survey question 3.6 'Has your project delivered new services and/or products on the market during the project or beyond the end date?'

The general tendency regarding liaison with SDOs, national standards bodies (NSB) and technical committees (TCs) is negative, with 70 % negative to 30 % positive answers.

Even in cases when SDOs were in some way involved in the project consortium, their participation had a minor impact on specific technological choices (see Figure 5). In some cases, the SDOs had insufficient field specific knowledge to get involved in standard development procedures. Other cases outlined the fact that some consortium members of the project had already been members of relevant TCs, and reflected on their expectations and assumptions.

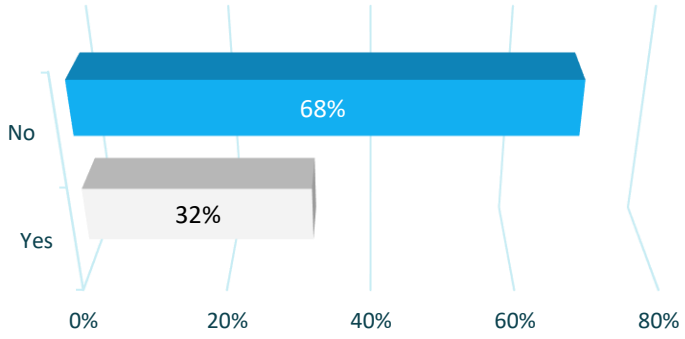
Figure 5 SDOs'/NSBs' impact on technological choices



Source: Survey question 4.7 'Did the implication of the SDO or NSB impact technological choices in any way?'

The overall picture is almost the same as above when it comes to collaboration with SDOs or NSBs outside a project, with around 70 % answering no and 30 % answering yes to the question (see **Error! Reference source not found.**).

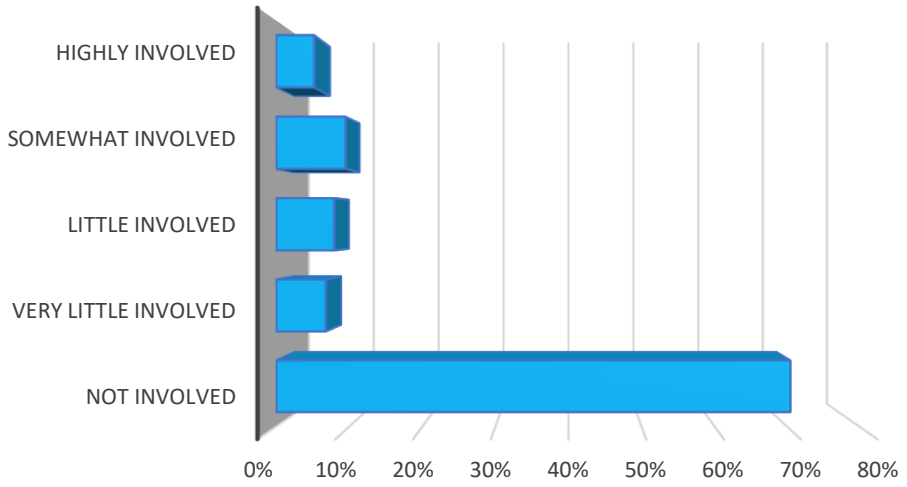
Figure 6 Collaboration with SDOs or NSBs outside the project



Source: Survey question 4.9 'Have you been in collaboration with SDOs or NSBs outside the project?'

Some 70 % of projects did not involve SDOs directly in the project (see Figure 7). Among those that did, we see considerable variation regarding the level of involvement.

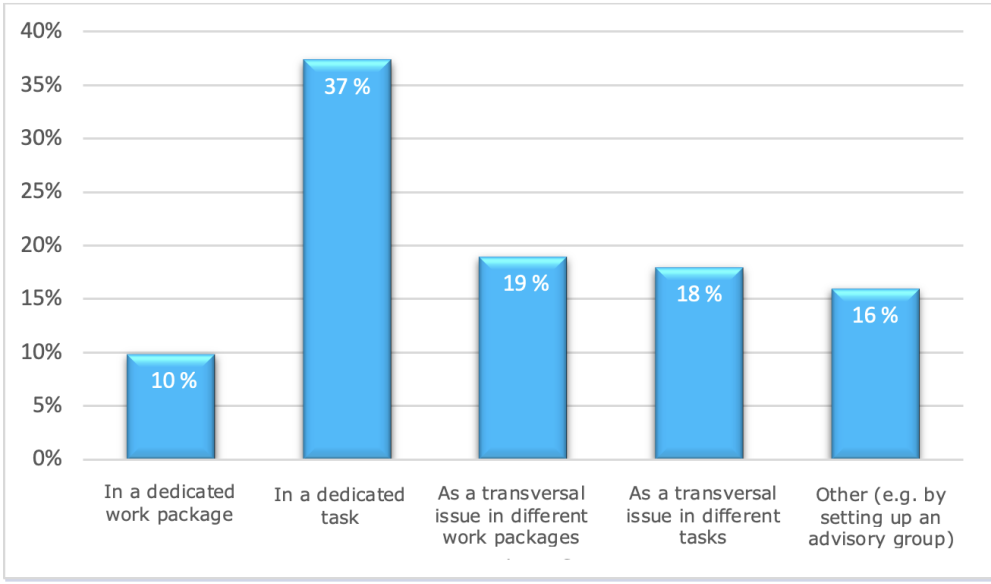
Figure 7 The extent of the Involvement of a standardisation entity in the project



Source: Survey question 4.11 'To what extent was the external standardisation entity involved in the project?'

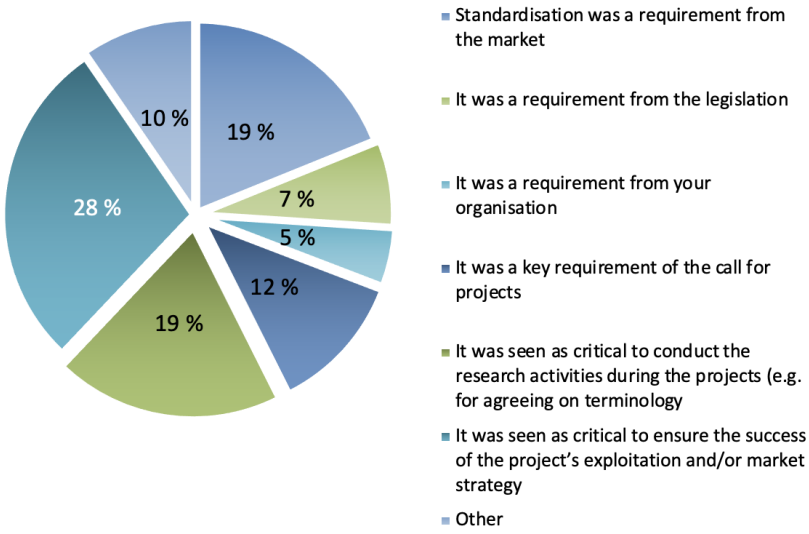
It appears from the answers to the question in the fifth block that most of the surveyed projects attached some level of importance to the topic of standardisation in their projects. Nearly 40 % of the respondents mentioned that it was addressed in a dedicated project task (see Figure 8), 10 % even as a dedicated work package (WP). The most common reasoning behind bringing standardisation into the project was that standardisation was critical to ensuring the success of the project's exploitation and/or market strategy.

Figure 8 The placing of standardisation activities within a project



Source: Survey question 5.2 'In your project standardisation activities have been addressed …'

Figure 9 Reasons behind addressing standardisation in a project

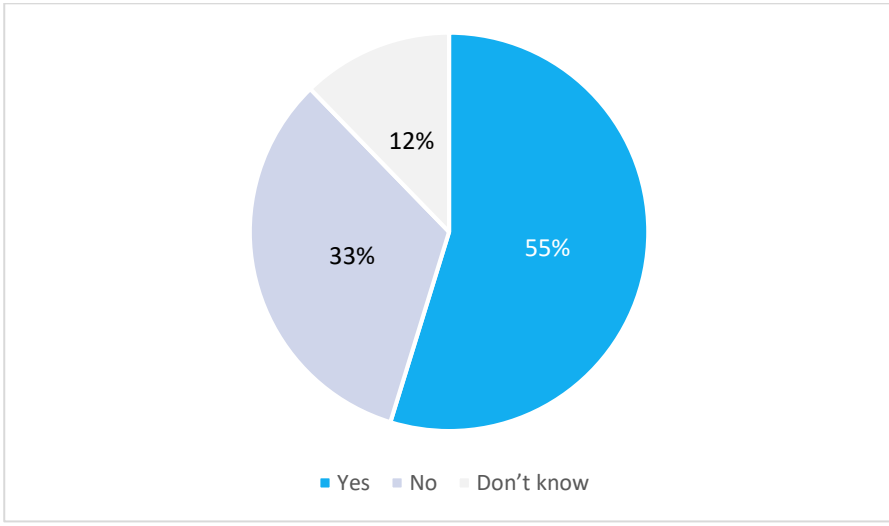


Source: Survey question 5.5 'What were the main initial reasons for addressing standardisation in your project?'

In block 6, which relates to referring to and/or considering the existing standards for the benefit of the overall project, the respondents tended to provide more positive than negative answers, as seen in

Figure 10. While the 12 % answering 'don't know' with respect to whether an existing standard was assessed seems a high proportion, we interpret this figure to mean that, as there were projects that did not have specific WPs for this function, it could neither be confirmed nor excluded that a researcher in the project had made such an assessment rather informally.

Figure 10 Inclusion of a review or assessment of existing standards to understand if any would have been useful for a project

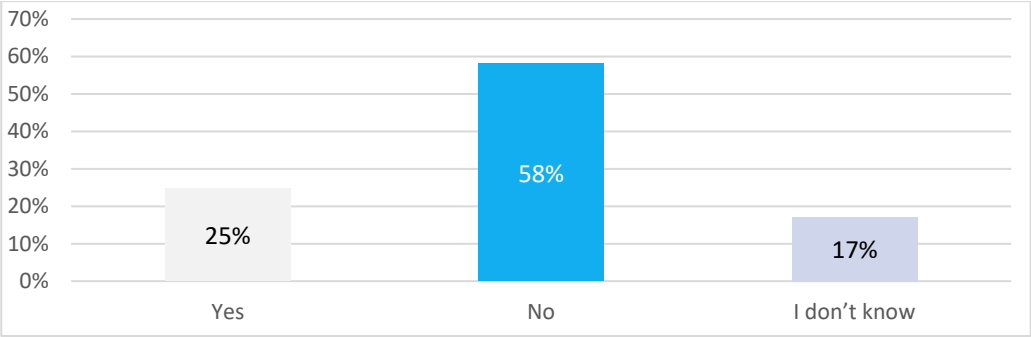


Source: Survey question 6.1 'Has your project involved a review or assessment of existing standards to understand if any would have been useful for your project?'

Regarding the development of new and/or revision of existing standards (block 7), the majority of respondents noted (as shown in

Figure 11) that their project was not directly involved in or did not directly lead to a specific recommendation or proposal for the development of new or revised standards. Again, the rather large 17 % share answering 'don't know' could perhaps be explained by possible links between the projects and the development/revision of standards having not been captured and happening rather informally, 'under the radar'.

Figure 11 A link between a project and the development/revision of standards



Source: Survey question 7.1 'Has your project directly involved or led to a specific recommendation or proposal for the development of new or revised standards or was aimed at supporting the development or revision of a standard already under development?'

Finally, when asked whether the given project could be considered a best practice case, some 40 % of respondents provided negative answers and some 60 % saw their project as a good example to be referred to or promoted further. However, when it comes to using, proposing or developing standards as part of future research projects, positive answers prevail (78 % versus 22 %).

In addition to the descriptive analysis presented above, clusters in frequency drew our attention to specific questions that needed further analysis. Multiple cross-tabulations have been performed to find possible influences between variables. Due to the relatively low granularity of questions, they showed low to medium correlations between many output variables.

Key findings from literature review

Literature on the role of standards and standardisation in technology transfer, and more specifically in research projects, is not widespread and has been developing only relatively recently. This goes together with the observation that standardisation has not been traditionally and widely recognised as a channel of technology transfer from science to industry ([13]) and is usually not mentioned in, for example, (theoretical) discussions of

([13]) Radauer (2020).

technology transfer channels ([14]), practical discussions on policy measures ([15]), impact model pathway elaborations for Horizon projects ([16]), the reporting of indicators for technology transfer ([17]) or studies assessing different types of incentives for researchers and their career progression ([18]). When describing some technology transfer practices of individual research organisations, Asunción et al. ([19]) mention standards and standardisation as valorisation channels, but then deal with this topic neither in the main report section nor in the recommendations.

A recent and seminal publication that explicitly aims to describe the current state of the art, and offers success factors for standardisation undertakings, however, was created as a collaboration between two Fraunhofer institutes ([20]). It draws on the

results of an analysis of standard-essential patents and publications, a literature analysis and 44 qualitative interviews (20 of which were with firms, 20 with research organisations and 4 with SDOs and/or associations). The literature analysis screened some 1 000 publications and singled out the 20 that dealt with standards and standardisation as an 'instrument of knowledge and technology transfer' ([21]). The interviews were to validate and complement the literature analysis results and seem to be the major source of information described in the following paragraphs ([22]).

According to the study authors, the major **drivers** of engaging in standards and standardisation activities are the following.

- **Contract research and networking:** For both research organisations and firms, standards and standardisation activities provide a means to create new contacts, mutual trust and a common language that can serve as a basis for future collaborations. Small and medium-sized enterprises (SMEs), in particular, also reported using standards/standardisation as a sales channel / business development tool by approaching potential customers in committees.

- **Diffusion of research results:** Several interviewees, particularly from research organisations, reported that standards and standardisation were necessary to enable the application of R & D results in practice. This relates to both phases: while developing a standard (when knowledge with other organisations is shared and

([14]) Etzkowitz, H. and Leydesdorff, L. (2000), 'The dynamics of innovation: from national systems and "Mode 2" to a triple helix of university–industry–government relations', *Research Policy*, Vol. 29, pp. 109–123.
([15]) Kallf-Lena, S. (2021), *Towards a policy dialogue and exchange of best practices on knowledge valorisation*, European Commission.
([16]) Van den Besselaar, P., Flecha, R. and Radauer, A. (2018), *Monitoring the Impact of EU Framework Programmes: Expert report*, European Commission, DG Research and Innovation.
([17]) Cavalade, C. and Kreiling, L. (2020), *ASTP 2020 survey report on knowledge transfer activities in Europe: Financial year 2018 data*, ASTP – A World of Knowledge Transfer.
([18]) Van de Burgwal, L. H. M., Dias, A. and Claassen, E. (2019), 'Incentives for knowledge valorisation: a European benchmark', *Journal of Technology Transfer*, Vol.44, pp. 1–20 (https://link.springer.com/article/10.1007/s10961-017-9594-8).
([19]) Asunción, M., Bausells, J., Reverter, J., Romero, J.-A. and Thévenod, P. (2017), *Handbook on good practices for valorisation of R & D results*, Interreg VI and Sudoe, pp. 15-21 (https://4.interreg-sudoe.eu/contenido-dinamico/libreria-ficheros/D2BC69BB-933E-CE7E-9E98-4B99072BCAE3.pdf).
([20]) Hermann, P., Blind, K., et al. (2020), *Relevanz der Normung und Standardisierung für den Wissens- und Technologietransfer* [Relevance of standards and standardisation for knowledge and technology transfer], Fraunhofer Gesellschaft e.V., Munich. Note that the study inquired into drivers of and barriers to engaging in standardisation activities per se, not specifically into grant-funded collaborative research projects. Hence, barriers and enablers are to be understood here in a wider context.
([21]) Ibid, pp 6-7.
([22]) The interview guidelines were developed with the help of the literature analysis.

complemented) and after publication of the standard (further diffusion through application of the standard).

- **Consideration of strategic interests:** Large firms, in particular, use standards and standardisation as a strategic tool, with standards being aligned with the strategic interests of the firms.

- **Standard-compliant realisation of technologies:** Several industries such as medical technologies need to cater for standards and standardisation issues. Furthermore, being involved in standardisation activities was reported to lead to shorter time to market in these contexts.

- **Impetus for the development of technologies:** Intense collaboration during standardisation works helps identify research gaps, which can then be addressed in R & D projects and for attracting parties to collaborate on them.

- **Reputational effects:** Being involved in standardisation has positive reputational effects at organisational level (with organisations being perceived more as leading institutions in their field) and individual level (when working in standardisation fosters recognition as being an expert in the field, which could help to advance careers (mostly within firms) and increase the chance of being invited to further standardisation committees and expert forums).

- **Knowledge sourcing:** Standardisation can be used, particularly by SMEs with limited resources, to source knowledge ([23]).

- **R & D collaborations:** Only some interviewees saw involvement in standardisation activities as also a driver of setting up collaborative R & D projects (although the networking effects may in turn lead to identifying potential R & D projects). This result may be interpreted as meaning that standardisation is not done to create R & D projects, but R & D projects may be a secondary outcome.

- **(Non-)Strategic hindrance of patenting:** Standardisation was reported not to be a tool to limit the freedom of competitors to operate but, on the contrary, was said to enable the creation of standard-essential patents, for example.

- **Cost-free membership of SDOs for research organisations:** Such memberships may in part help them to engage in standardisation.

The study authors noted the following **barriers** to engaging in standardisation.

- **Lack of knowledge of standards/standardisation:** This was identified as a major factor hindering more intense involvement with standardisation activities at several levels. Such know-how is usually not part of tertiary education in relevant fields. Lack of know-how and information about possible benefits of standards/standardisation at executive level translates into difficulty securing investment and budgets for corresponding activities and, in the more extreme cases, committee work ending up

([23]) While the source cited only makes specific references to this one possible specific benefit of standardisation for SMEs, other pieces of literature investigate such benefits of standardisation for SMEs more closely. Further SME-specific benefits are, for example, forming partnerships with other participants; opportunities to access potential customers; and benefits of common marketing of standardised technology, paid for by larger companies. See Le Gall, F. and Prager, M. (2011), *Participation of SMEs in Standardization*, ETSI white paper No 6.

as pro bono / unpaid activity of experts in their free time. Secondly, there is also a lack of process know-how, even if the benefits are in essence understood. Thirdly, the jungle of standards was reported to make it difficult to track recent developments in standardisation and to single out the most relevant committees and their added value.

- **Financial barriers:** Standardisation requires commitment and effort, which also translate into considerable costs (e.g. travel costs for participating in committee meetings, time spent on standardisation activities).

- **Long-term nature of standardisation processes:** There is significant dismay that standardisation processes usually last considerably longer than projects – an important issue in view of bridging R & I projects and standardisation. The reasons for this are manifold but include challenges in involving enough relevant stakeholders in standardisation processes at the beginning, cultural reasons (within a company, but also across countries) and the necessary time it takes to create a common language, trust and consensus among committee members.

- **Lack of recognition of standardisation work for researchers:** Researchers must be intrinsically motivated to participate in standardisation, as this is not a factor considered in assessing their performance and career advancement prospects.

- **Standards as a shared outcome (no mention of authors):** In contrast to publications and patents, standards do not mention their authors. This makes it difficult to measure and track the contributions of researchers and is also a factor feeding into the lack of recognition described previously. At best, standards may reference publications in their bibliographies ([24]). This leads to the newly developed notion of standard-essential publications, which can perhaps also be used as one indicator to track certain aspects of technology transfer from R & D into standards.

- **Free-rider problem:** To some extent free-riding has been described as a barrier, i.e. organisations collecting information from others in committees but being otherwise passive and not contributing to the process themselves. This demotivates others from engaging more. However, this factor was only of concern for a small number of interview partners in the study.

- **Standards as public goods:** Standards are public goods and not a type of IP. The ensuing lack of control over how standards are commercialised has been cited by both research organisations and firms as a barrier ([25]).

The study finally asked its interview partners about **common success factors** for standardisation undertakings and found that these can be split into individual/organisation-specific factors and common success factors. They are displayed in**Error! Reference s ource not found.**.

Table 1 Overview of success factors for standardisation undertakings

([24]) See also Blind, K. (2019), 'Case: Publizieren, Patentieren und Standardisieren. Die besten drei zur Verwertung – Vergleich der Strategie-Trias für Wissenschaft, Forschung und Entwicklung (F&E)' [The best three for appropriation – comparison of the triad of science, research and development], *Wissenschaftsmanagement*, Vol. 2, pp. 13–23 (https://www.wissenschaftsmanagement.de/dateien/k2_wima_2_2019_cases_blind.pdf).

([25]) However, one could also argue this to be a positive point from a societal point of view, similar to open science approaches.

Success factors	Description
Success factors at individual/organisation-specific level (to ensure that organisational interests are being properly taken into consideration in committees)	
Personal competencies and expertise	Domain knowledge Social competencies (being able to compromise) Business skills (understanding strategic and operative effects of activities on own organisation) Being able to keep things secret, being able to take decisions Linguistic skills (ability to draft texts in standard-compliant language) Persistence
Existence of strategic alliances	Facilitates assertion of interests Based on existing networks and networking skills
Selection of the 'right' committee	The more relevant one's own know-how/technology is to a committee, the more influential one can be Particularly relevant for SMEs who have otherwise little market power-based leverage
Success factors for overall standardisation undertaking	
Thematic fit of participants	Thematic complementarities and synergies High degree of individual domain expertise
Practical relevance of the project	Standard fills a gap and meets a need
Involvement of an industry partner	Facilitates bringing other partners into the project Increases likelihood that the standard is later taken up in practice
Previous experience with standardisation work	Successful collaboration in past projects provides a basis for further undertakings Informal links in committees may lead to future projects Understanding of how standardisation processes work increases efficiency and effectiveness
Existence of a 'driving force'	People who motivate others to participate and increase the likelihood of success More intense contribution results from own interest in the standard (relevance, urgency)
Right timing	Dependent on driver and technology choosing the right timing for initiating standardisation activities

Source: Hermann et al. (2020).

Alongside the recommendations geared mainly at policymakers, the study authors also advise that organisations (i.e. firms, research organisations) should create their own standardisation strategies and assign persons/departments to that topic. This can be also considered a success factor.

Apart from the Hermann et al. study, there are other sources of literature that are useful when developing recommendations for researchers engaged in standardisation activities and/or outlining success factors for research projects dealing with standardisation.

- Lorenz et al. (2019) ([26]) discuss the utility of standardisation in the context of product and process development in biotechnology. The authors build on the important distinction that, for many products to be able to reach the market, it is necessary to develop not only the product itself but also an accompanying process to scale up production capabilities from lab to large industrial scale. This aspect of process development has not yet been well researched (as opposed to product development and the R & D steps needed to get to the product). In the case of biotechnology, the authors use a framework consisting of technological, operational, organisational, relational (between product and production process) and market determinants (e.g. customer requirements, regulatory requirements), which create uncertainty for both product and process development. The authors show that standardisation can be one tool to reduce these uncertainties. The concrete areas where standardisation plays a role comprise platform technologies (some form of basic 'standard' technology, from which other technologies can be derived), product quality monitoring and the area of standardised transfer protocols, which enable the transfer of data between different labs. The value of this particular paper lies in highlighting specific areas in an industry where specific types of standardisation enable technology transfer.

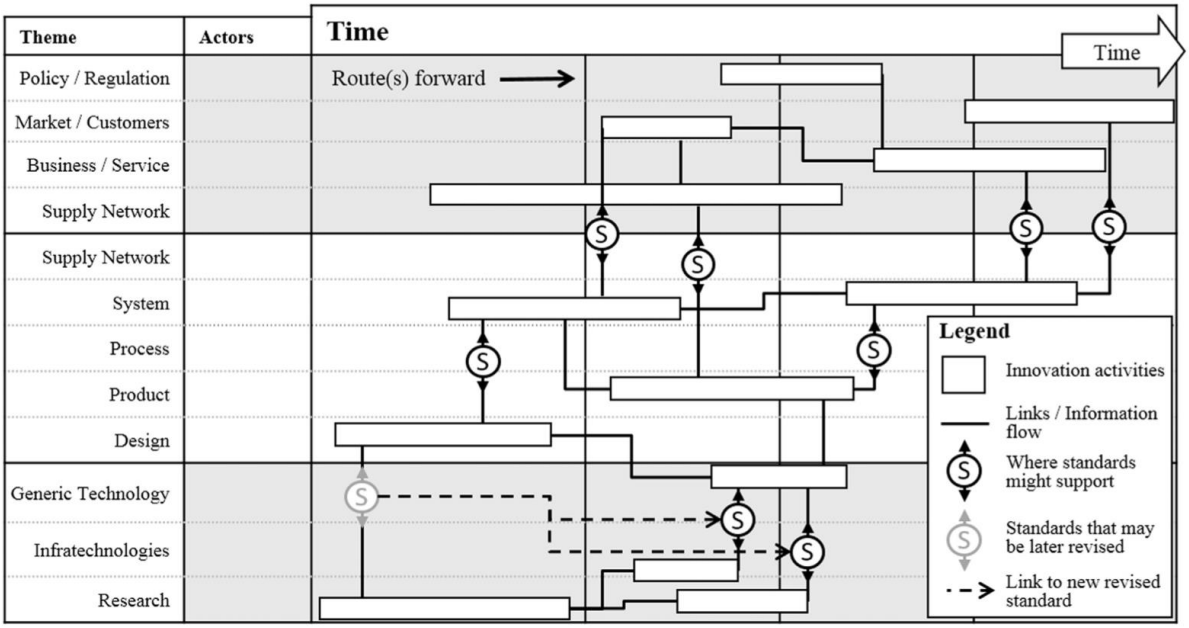
- Featherston et al. (2015) ([27]) created a standard-mapping framework. This framework also draws on the methodological foundation of technology roadmapping, adapting this methodology to a method by which standardisation opportunities can be identified in emerging technologies. The framework hereby caters for different types of standards and allows them to be linked to different innovation activities. The generic framework is depicted in Figure 12 . The framework was then tested retrospectively on three technologies – synthetic biology, additive manufacturing (AM) and smart grids – as a proof of concept that the framework can be useful. The authors also recommended the application of the framework for future standardisation needs assessments 'to evaluate just how useful the framework is for anticipating future standardisation opportunities'[28].

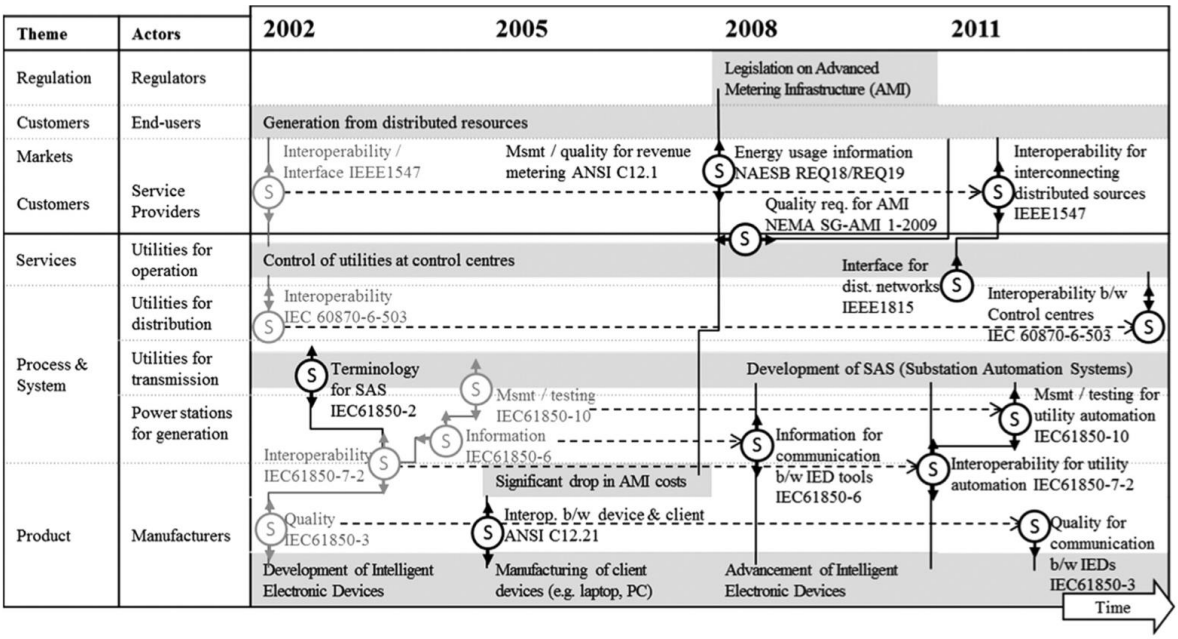
Figure 12 Standard-mapping framework – generic and applied retrospectively to smart grid technology

([26]) Lorenz, A., Raven, M. and Blind, K. (2019), 'The role of standardization at the interface of product and process development in biotechnology', *Journal of Technology Transfer*, Vol. 44, pp. 1097–1133 (https://doi.org/10.1007/s10961-017-9644-2).

([27]) Featherston, C. R., Ho, J.-Y., Brévignon-Dodin, l. and O'Sullivan, E. (2016), 'Mediating and catalysing innovation: A framework for anticipating the standardisation needs of emerging technologies', *Technovation*, Vols 48–49, pp. 25–40 (https://doi.org/10.1016/j.technovation.2015.11.003).

([28]) Ibid, p. 38





Source: Featherston et al. (2016).

- Similarly, Ho (one of the co-authors of the Featherston paper) and O'Sullivan subsequently developed a systematic matrix ([29]), based on the literature, which can guide researchers through the decision process for what, why, when, how and where to consider standardisation (see **Error! Reference source not found.**). Further to that, t hey applied it systematically in technology roadmapping using the photovoltaic industry as a case study.
- A simpler way to determine the extent to which standardisation is a topic for a research project is a checklist provided by CEN-CENELEC ([30]). The checklist has a series of questions that can be answered with 'yes' (e.g. on aspects such as whether R & D results need to be interoperable or comparable and whether it will need to comply with EU regulations). The more 'yes' answers, the more likely it is that standardisation has to play a role in the research project. Another brochure provides complementary basic information on how and where standards could fit into research and innovation activities ([31]).

Figure 13 Guidance on parameters regarding decisions related to standardisation in research projects and innovation undertakings

([29]) Ho, J.-Y. and O'Sullivan, E. (2018), 'Standardisation framework to enable complex technological innovations: the case of photovoltaic technology', *Journal of Engineering and Technology Management*, Vol. 50, pp. 2–23 (https://doi.org/10.1016/j.jengtecman.2018.07.003).

([30]) CEN-CENELEC (n.d.a), 'Standards + innovation – bring your research and innovation to the market via the fast lane' (https://d298e79a-4e8f-4892-a07374d3a48ede86.filesusr.com/ugd/b28c29_3e8b748723904efd95c71c8c0833f852.pdf).

([31]) CEN-CENELEC (n.d.b), 'Standards + innovation: guidance for considering standardization in European Framework Programmes, calls, topics and projects' (https://d298e79a-4e8f-4892-a073-74d3a48ede86.filesusr.com/ugd/b28c29_9c11e54c14a0472c994d8dfd4579bec8.pdf).

Table 2
Exemplar categories for dimensions of standardisation.

Dimensions		Exemplar categories (strategic and tactical choices)		
S1	'*What*' innovation activities are relevant to standardisation	Market-related activities	Industry environment	
			Policy / regulation	
			Market / customers	
			Business / service	
			Supply network	
		Production-related activities	System	
			Production	
			Product / application	
		Technology-related activities	Proprietary technology	
			Generic / platform technology	
			Infratechnology	
			Science base	
S2	'*Why*' standardisation is needed		Terminology and semantic standards	
			Measurement and characterisation standards	
			Quality and reliability standards	
			Compatibility and interface standards	
			Variety-reduction standards	
S3	'$When_{(RT)}$' to be standardised	(in terms of 'Real-Time')		
	'$When_{(TLC)}$' to be standardised	(relative to 'Technology Life-Cycles')	Anticipatory standards	
			Participatory standards	
			Responsive standards	
T1	'*How*' to standardise	(types of deliverables)	International Standards (IS)	
			Technical Specifications (TS)	
			Publicly Available Specifications (PAS)	
			International Workshop Agreements (IWA)	
			Technical Reports (TR)	
		(form of specifications)	Performance standards	
			Solution-describing standards	
		(modes of coordination)	Committee-based standardisation	
			Market-based standardisation	
			Government-based standardisation	
T2	'*Where*' standards are developed	(organisations leading standardisation)	(committee-based)	Formal Standards Organisations (FSOs)
				Sectoral / Specialised Standards Organisations (SSOs)
				Consortia / Research initiatives
			(market-based)	Individual market actors
			(government-based)	Public agencies
				Government laboratories
		(geographical areas)		
T3	'*Who*' is participating in standardisation		Consumers	
			Government	
			Industry (companies)	
			Consultants	
			Researchers	

Source: Ho and O'Sullivan (2018).

Figure 14 Five steps with tools and outcomes for integrating standardisation in a research project

Steps	Examples of Tools	Expected Outcomes
1. Analyze the state of the art in standardization	Databases for standards search, such as PERINORM or the Online Browsing Platform (OBP) of ISO	List of existing standards classified according to the projects content (see, e.g., [55,64,65]).
2. Identify end-user needs and standardization gaps	Open survey and/or workshop to identify end-user/cities' needs; internal workshop to define individual assessment criteria	Overview of standardization potentials based on project results (see, e.g., [68,69]).
3. Define project standardization strategy	Project internal meetings and formal exchanges with relevant standardization committees	Standardization strategy with implementation plan (see, e.g., [68,72]).
4. Initiate end-user focused standardization activities	(CEN) Workshop with project and external partners on standardizing project results during the project	Standardization activity like CWA or input to existing/draft standard (see, e.g., [63,70,73]).
5. Promote and exploit the standardization activities	Presentations at (scientific) conferences, summarizing promotional material, etc.	Increased visibility and uptake of standardization deliverables beyond the project (see, e.g., [63,80]).

Source: Lindner et al. (2021a).

- A fairly recent paper that is highly relevant to the underlying study is the analysis by Lindner, Jaca and Hernantes (2021a) ([32]). Its significance comes from assessing specifically the approach to standardisation in 10 framework programme projects as case studies, dealing with the topic of how to make cities more resilient against crises. One of the key outputs of the analysis is a five-step procedure for 'integrating standardisation in research projects with a focus on (city) resilience', which 'shows the benefits of the standardisation process for fostering the engagement of relevant stakeholders.' The procedure is depicted in **Error! Reference source not found.**.
- Another recent paper by Lindner et al. investigates the use of standardisation in the H2020 project Advancing resilience of historic areas against climate-related and other hazards (ARCH), which deals with disaster risk management for historic areas of cities. The paper 'highlights the systematic inclusion of project-external stakeholders who actively contribute to the validation and enhancement of the ARCH framework to guarantee maximum applicability in historic areas, supporting them in their fight against the impacts of climate change and natural hazards' ([33]).
- Hatto (2013) created a guide that was published by the European Commission for researchers venturing into standards and standardisation ([34]). The document, is an

([32]) Lindner, R., Jaca, C. and Hernantes, J. (2021a), 'A good practice for integrating stakeholders through standardization – the case of the smart mature resilience project', *Sustainability*, Vol. 13, 9000 (https://doi.org/10.3390/su13169000). The paper is also referenced in our case study No 35 below.

([33]) Lindner, R., Lückerath, D., Milde, K., Ullrich, O., Maresch, S., Peinhardt, K., Latinos, V., Hernantes, J. and Jaca, C. (2021b), 'The standardization process as a chance for conceptual refinement of a disaster risk management framework: the ARCH project', *Sustainability*, Vol. 13, 12276 (https://doi.org/10.3390/su132112276).

([34]) Hatto, P. (2013), *Standards and Standardisation – A practical guide for researchers*, European Commission, DG Research and Innovation, Luxembourg.

interesting mix between an overall introduction into how the standardisation system and the related processes work, combined with occasional tips for researchers. Example of successful projects are given, although 'projects' seems to refer in most cases to committee work / developing a standard and only partly to framework programme / Horizon projects. Of particular interest is a checklist for framework programme projects whose leaders need/want to characterise their dealing with standardisation (more specifically, the 'specific research result identified as relevant to standardisation')[35]. Worth noting is the large number of questions relating to needs assessment ([36]). Otherwise, the document seems to be a good checklist for those researchers who want to reach out to TCs – it reflects the fact that a good level of knowledge of standardisation processes should ideally be in place when this is attempted. For the purpose of the study, it seems that questions pertaining to potentially existing intellectual property rights (IPR) issues to be resolved are of interest and could form a potential success element of good practice.

- The publication 'Increase the impact of your R & I project by integrating standardization' is an example of a brochure and guide produced by CEN-CENELEC with researchers in Horizon Europe as the target group ([37]). in eight pages, the brochure advocates a stepwise approach starting with assessing the possible standardisation needs of a research project (and hence rationales for integrating standardisation), going on to the screening of existing standards and the possible ways to contribute to standards, and, finally, giving rationales for when to use an SDO as a subcontractor for a project. The brochure is clearly aimed at beginners in standardisation. **Error! Reference source not found.** presents the rationales for integrating standardisation into R & I projects according to CEN-CENELEC.

Figure 15 Rationales for integrating standardisation in an R & I project

([35]) Ibid, pp 33-34

([36]) 'Why is the result relevant to standardisation and what purpose could it serve? Who are the possible contributors in the consortium? Are they prepared to participate in developing a standard in this area? What are their expected benefits? Do they see any obstacles and, if so, what are they? Are there IPR [intellectual property rights] issues involved? What are the estimated costs of taking the result to a finished standard? Have appropriate searches been undertaken to establish whether relevant national, European or International standards in the area already exist or are under development? If so, provide a list of standards and relevant technical committees? How will the new standard complement existing documents?', pp 33-34

([37]) CEN-CENELEC (n.d.c), 'Increase the impact of your R & I project by integrating standardization' (https://www.cencenelec.eu/media/CEN-CENELEC/Get%20Involved/Research_Innovation/standardization-in-research-projects.pdf). CEN-CENELC has also published similar brochures, e.g. CEN-CENELEC (2011) 'STAIR: an integrated approach for standardization, innovation and research', which outlines a framework for dealing with Horizon projects on standards and standardisation from a more integrated (and more policy-oriented) perspective.

What are your needs?	What can standardization contribute?	What should you include in your R&I project?
Have a starting point for your project	Standards are state of the art for industrial and societal practices	
Ensure methodological robustness Improve the quality of your project's activities and outcomes	Ensure compatibility of your results with what is already on the market	A task related to screening of existing standards
Ensure broad applicability of your project results	Comply with recognized test methods, health and safety requirements	A standardization partner or subcontractor
Increase the impact of your project Long term dissemination of your results	Give you access to discuss and promote your project outcomes with stakeholders and potential customers	Task(s) aimed at contributing to new standards
Ensure market acceptance of your project results	Disseminate your results to a relevant range of European or world-wide stakeholders	
	Ensure that your project results are known and used by the market well beyond the duration of your project	A standardization partner or subcontractor

Source: CEN-CENELEC (2011) 'STAIR: an integrated approach for standardization, innovation and research'.

- It is worth mentioning the key results of a support study during the Bridgit 2 project on the contribution of standardisation to European framework programmes for research and innovation: the seventh framework programme and H2020. Based on an interview sample, for example, it was found that the top three standardisation activities were the use of existing standards for the R & D activities (25 % of projects interviewed); developing, proposing or revising new standards (21 %); and drafting requirements for future standards (18 %). The study also provided indications that drawing on SDOs as project partners increased the project's chances of success (e.g. 87 % were satisfied with the collaboration with the SDO and 50 % had a follow-up to their standardisation outcome) ([38]). The Bridgit project also led to guidelines for SDOs on how to support research projects ([39]).

Finally, we sought to identify specific literature regarding indicator development to track the performance of standardisation activities as measures for technology transfer and knowledge valorisation. There is seemingly little such literature available, the exception being a

([38]) Bridgit 2 (2019), 'Key findings of a study on the contribution of standardisation to European framework programmes for research and innovation – FP7 & H2020' (https://d298e79a-4e8f-4892-a07374d3a48ede86.filesusr.com/ugd/b28c29_3c8dd8cdd9a549c9bdddf76ff82b5aec.pdf).

([39]) CEN-CENELEC (2015), *How to Link Standardization with EU Research Projects: Advice for CEN and CENELEC members*, Bridgit project (https://www.ideal-ist.eu/sites/default/files/toolbox/BRIDGIT-members-guide.pdf).

publication by Blind from 2019 that contrasts indicators for publications, patenting and (possibly) standardisation ([40]). The paper first repeats the observation that standards do not list their authors (however, the pre-standard reference specifications of the German Institute for Standardisation (DIN Specs) do list their authors). Against this backdrop, Blind suggests using literature referenced in the bibliography of standards documents, following the reasoning that there is a high likelihood that the referenced authors also participated in standardisation activities. This leads to the notion of standard-essential publications.

Similarly, patents declared essential for implementing a standard, i.e. standard-essential patents (SEPs), may also be used as standard-related performance indicators for technology transfer (It is worth noting that patents list their inventors as 'authors').

Apart from these two types of indicators, Blind suggests the following indicators related to standardisation activities:

- number of standards developed (but only in relation to DIN Specs, where the author is clearly visible);
- number of seats occupied by researchers in standardisation committees;
- initiation of joint standardisation activities (as a measure of collaboration);
- initiation of international standardisation activities (as a measure of internationalisation);
- chairing European or international standardisation committees (again as a measure of internationalisation).

In terms of current practice, Blind points to the observation that typically for few to none of these indicators are data being collected, except for research organisations, which often describe their participation in standardisation committees (working groups (WGs) and TCs) in their annual reports.

Key findings from the interviews

3.3.1. Elements of good practice in relation to the design phase (genesis) of a Horizon project

The interviews revealed the following elements of good practice in the preparation/genesis phase of Horizon projects.

- **Recognition of standardisation activities as valuable academic work when assessing research performance of researchers:** The first element of good practice addresses not so much individual researchers or projects, but rather the institutional level. Standardisation activities are often not recognised as valid and valuable outputs of research activities, when they could be ([41]). Hence, they do not play a big role in career advancement and, as a result, there may be little direct

([40]) Blind (2019).
([41]) Of course, it must be considered that this is specific to the research field, i.e. not in all types of research will standardisation be relevant.

incentive for researchers to participate in standardisation. A cultural change is needed here, as well as the development of performance indicators.

- **Clear need assessment for standardisation activities:** One interview partner particularly stressed the necessity for project consortia to consider whether 'there is a gap in standards and standardisation activities that needs to be closed in the research project'. It was said in this context that there must be an understanding that standardisation is not a goal in itself but a means to an end. To this end, it might also be good to liaise with TCs that work in the area of standardisation in question, to understand the possible gaps.

- **Mentioning standardisation and standards in Horizon call texts:** An indicator to be considered when assessing standardisation needs in a research project is whether and how the underlying call texts mention standards and standardisation in a dissemination and exploitation context. While an important issue, this addresses policymakers more than researchers.

- **Assessing the general role of standards/standardisation in an industry:** A parameter to look for when assessing the need for standardisation is the level of product complexity in an industry. Industries where the traded goods consist of several components that must interact with each other (or where there is a clear need for interaction with products from other markets) may be more subject to standardisation activities than single-component product markets. This relates to industries such as ICT, automotive and, to a degree, machinery. Another parameter to consider is regulatory requirements in the industry (in relation to health, safety and the environment) – this makes some industries (e.g. circular economy) particularly viable for standardisation. Finally, the TRL is to be considered. Standardisation may be particularly relevant for later-stage TRLs (as a means to transfer research into markets), but it also has a role to play in earlier TRLs ([42]).

- **Proper understanding of standards and standardisation:** One interview partner, in particular, mentioned the necessity of researchers having a good understanding of what standards and standardisation are about. Lack of understanding leads many researchers to believe standards may be an activity that often happens during pre-normative research and hence often in relation to measurement methods, whereas 'they [the researchers] work on setting a "standard"'. However, standardisation is work that happens at later stages and involves working together with outsiders/communities to find consensus on standards and not in 'silos within a research project' (interview partner) ([43]). Along the same lines, researchers often do not understand that standards/standardisation are a tool for the commercialisation of R & D results ([44]), so they lack a business perspective. All of this goes hand in hand with a lack of detailed knowledge of how standardisation works in general.

- **High experience level and involvement of participating researchers with standardisation and standards:** Not only following from the previous point, there is consensus among the interview partners that a strong success factor is to have

([42]) The difference is often that early-stage TRLs correlate with standardisation on terminology, while later-stage standardisation is more about interconnectivity.

([43]) However, it was stressed by an interview partner that standardisation work can be started in parallel to research work (e.g. in the time frame of a research project), to avoid the mistaken impression that the relationship between R & D and standardisation is purely linear.

([44]) This of course assumes that researchers are per se interested in the commercialisation of research results, which cannot be taken for granted.

persons on the team with profound experience in standardisation activities. Ideally, those persons should sit on the TCs for the standardisation activities in question, perhaps even chairing them. The benefit of having such persons is the increased probability that research activities are taken up in the actual standardisation processes, which can last considerably longer than the lifetime of a project. However, it was also mentioned that by no means all researchers need be experts in standardisation.

- **Tangible standardisation components in the proposal:** There is a necessity, once a clear need for standards / standardisation activities is identified, to define tangible components such as dedicated WPs and/or tasks across WPs, underpinned with budgets and leading to well-defined deliverables and outputs. This does away with 'standardisation washing' *(*interview partner) in proposal writing and is said to correlate with project success.

- **Involvement of SDOs as project partners:** Involving SDOs in research proposals as project partners may be an element of good practice, but this necessitates proper know-how about how to put SDOs to use. SDOs of course do have standardisation know-how, can help structure the work, reach out to the most important stakeholders and/or map the standards/standardisation landscape for Horizon consortia. Furthermore, several SDOs have identified participating in research projects as an activity of interest to them. On the negative side, however, is the lack of knowledge that SDOs are private organisations (and not public agencies like funding agencies), which may lead to a certain initial reluctance of researchers to involve and proactively approach SDOs. But there are also other, potentially bigger, issues to consider. While SDOs, as organisations, could be good project partners, it is actually the TCs that perform the standardisation activities and have the final say regarding the uptake of research results in standardisation activities ([45]). It could well be that TCs reject the research activities of the Horizon projects, despite involvement of SDOs. Furthermore, SDOs are not research organisations / researchers. Some of them may also have tunnel vision about the research topics in question, in the sense that they are focused on their own standards / standardisation activities and have less insight into and consideration for the activities of other SDOs (which is disputed by some SDOs, which explain that SDOs need to focus on the needs of the whole cast of stakeholders, not on individual standards). Finally, while some SDOs promote getting involved with them as project partners and/or offering support units/departments for researchers as part of their core work, others may 'often see Horizon activities as a distraction from their fundamental work' (interview partner).

- **Stakeholder management:** The bullet point above hints at the importance of stakeholder management already in the planning phases of a Horizon project. The necessary stakeholders in standardisation should be actively identified, possibly approached and their interest raised. This refers, in particular, to the TC, with which links should be built early, if they do not already exist. It could be envisaged that TC members are made part of the advisory and steering boards of the projects. It should be recognised that standardisation is a multi-stakeholder process, in which – depending on the topic of standardisation – representatives from industry, including SMEs, public authorities, conformity assessment bodies, non-governmental

([45]) According to an interview partner, this procedure is part of the democratic process to develop well-accepted standards.

organisations (NGOs), consumer organisations, etc. are involved in the drafting of standards.

- **Industry involvement:** In terms of stakeholder management, a viable approach would be also to obtain industry support. With industry participating in the research projects, the likelihood of standardisation activities being successful and taken up increases.

- **Elements of flexibility in the actual planning of standardisation activities in the proposal:** One interview partner mentioned specifically the planning of standardisation activities in a flexible way (e.g. not being too precise about outputs), despite the unchallenged need for tangibility of standardisation in research projects. For example, it might turn out that, while one TC may be negative about the research project, other TCs (in another industry, for example), may be positive. The proposal should cater for such developments, which can only partly be planned in advance.

It becomes clear from the list that most elements of good practice relate to the genesis/design phase of a Horizon project, indicating that good advance planning is essential for project success in relation to standards and standardisation.

3.3.2. Elements of good practice relating to the implementation/running time of a Horizon project

Following sound and thorough planning of the project, the interview partners mostly identified the following major factors to be looked after during project implementation.

- **High degree of interaction with stakeholders during implementation:** Already hinted at in the design phases, regular to continuous interaction with the stakeholders is seen as a key success factor during the running time of a project. It involves these actions, among others.

    - **Synchronising activities with the TCs:** When reaching out to TCs, researchers should be aware of synchronising issues between the project timetables and the dynamics of standardisation activities. It could well be that the research activity is at a too early stage for the TCs; the issue is nonetheless 'to get the TCs interested' (interview partner).

    - **Continuous communication and outreach:** It is advisable to properly inform stakeholders, particularly users, about the ongoing project activities and to get them involved, to the extent feasible and possible.

- **Participation in ongoing standardisation activities:** It would be good to participate in ongoing standardisation activities. However, even if a TC is interested, researchers may find out that this is not possible in practice. For example, in construction there is a need to test cements with a lifetime of 30 years or longer to create a standard, and the corresponding time for testing may be much longer than the project duration (in this case, probably also longer than it takes to develop a standard in other areas, which already needs more time than usually catered for in an R & D project).

- **Good project management ('follow the plan'):** Highlighting the need for good planning, the interview partners also pointed to the need to execute the plan properly, and voted for good project management to be a (generic) indicator of an element of good practice.

3.3.3. Elements of good practice relating to performance (outputs/outcomes/impacts) of a Horizon project

The interview partners recognised the difficulties in establishing clear-cut performance indicators for the outputs, outcomes and impacts of standardisation activities. Like patents, for example, standards/standardisation are only one of many factors contributing to successful commercialisation and innovation. Its immediate contribution needs to be assessed, probably in context-specific ways. Nonetheless, some indicators may help the assessment and provide a means to monitor progress.

- **Number of CWAs and similar pre-standard reference specifications (as outputs/outcomes):** The number of CWAs (and of similar instruments such as DIN Specs) is certainly an indicator that can be tracked, but it has to be interpreted carefully. On the positive side, CWAs can be tangible standardisation-specific outcomes of Horizon projects. Because they do not require full consensus among industry stakeholders, CWAs can also be created within the time frame of a Horizon project (which is mostly too short for the creation of a 'true' standard'). Moreover, by being made accessible centrally by CEN-CENELEC on its website, CWAs may be easily found over extended periods of time, and hence also the chance of their being taken up increases (in contrast to technical reports, for example). On the negative side, because CWAs do not require full consensus, they may turn out to become irrelevant if the TCs or the corresponding 'true' standardisation activities discard or ignore them. Against this backdrop, CWAs may also be no more than printed paper – this again underlines the importance of TC backing for a research project. A measurement difficulty is also that CWAs are never cited directly in standards documents, so using a 'citation index' as a measure of impact like with patents is difficult to create. Relevant citations may be found in the meeting minutes of TCs. To mitigate some of these risks, CEN-CENELEC has published guidance ([46]).

- **Contribution to an existing or new standard / proposition regarding the creation/revision of a standard:** Propositions regarding a necessary revision/creation of a standard, as well as contributions to an existing standard, can be considered standardisation-specific project outputs, too. However, because of the citation issues, as described above, the links to the project must be made plausible.

- **Maintenance of project results after project termination / sustainability:** The end of the lifetime of a project (and hence funding) may result in standardisation outputs such as CWAs no longer being 'supported'. Researchers involved in the project may need to move on, and, for example, if a revision of a CWA is necessary or if there is a query regarding the details of the CWA, nobody knowledgeable can be reached. Therefore, describing the afterlife/sustainability of the standardisation outputs in the proposal and having relevant measures in place can be also seen as a measure of good practice.

- **Difference in TRL:** Technologies may advance during a project from a lower TRL to a higher TRL. Interview partners agreed that the difference in TRLs may be an important performance indicator to track, for standardisation or to gauge the success

([46]) CEN-CENELEC (2020a), *CEN-CENELEC Guide 23 – Research consortium bridge – Addressing research and innovation in European standardization activities and deliverables* (https://www.cencenelec.eu/media/Guides/CEN-CLC/cenclcguide23.pdf); CEN-CENELEC (2020b), *CEN-CENELEC Guide 29 – CEN/CENELEC workshop agreements – A rapid way to standardization* (https://www.cencenelec.eu/media/Guides/CEN-CLC/cenclcguide29.pdf).

of standardisation in research projects, among other purposes. The higher the TRL, the more standardisation could crop up as a topic of relevance. It was, however, also said that different TRLs are indicative of different standardisation needs. Whereas higher TRLs are more associated with standardisation issues such as interoperability, at lower levels there is often the need to standardise terminologies. This implies that standardisation can also be important for lower TRLs.

- **'Good' project outputs:** Project outputs such as publications, patents, innovations (new or improved products/services entering a market) will probably also correlate with the standardisation success of research projects, if standardisation has been identified as an important success factor for delivering and/or diffusing such outputs.

The exact composition of which indicators are relevant for which project will be context specific. It could depend on factors such as whether standards already exist (or whether the technology is just beginning to evolve).

Generally, it can be said that the results of the interviews align well with the findings of the literature.

Overview of case study projects

We turn now our attention to the case study projects as our last source of evidence. Table 2 provides an overview of the projects selected for further scrutiny as case studies (henceforth called case study projects). To perform the analysis, we conducted an additional interview with each project leader and/or the representative(s) in charge of standardisation of the projects and combined this with answers from the European Commission survey and document analysis (project home pages and reports, CORDIS database) ([47]). The full write-ups of the case studies can be found in Annex 1. We want to underline that the case studies have been numbered randomly, so the numbering does not imply any kind of ranking (see also Section 2.2).

Table 2 Overview of case study projects

([47]) The only exception is case study 35, for which it was not possible to conduct an interview but we had access to an extensive analysis of the project in terms of standardisation activities as described in the publication of Lindner et al. (2020) on the smart mature resilience project, on top of the responses obtained for the project through the European Commission survey.

1	Large additive subtractive integrated modular machine (Lasimm)
2	OntoCommons
3	Nextower
4	Innovative multifunctional vacuum insulation panels for use in the building sector (InnoVIP)
5	Wide-scale demonstration of integrated solutions and business models for European smart grid (WiseGRID)
6	Coordination of transmission and distribution data exchanges for renewables integration in the European marketplace through advanced, scalable and secure ICT systems and tools (TDX-Assist)
7	Agent-oriented zero-defect multistage manufacturing (GO0D Man)
8	Fostering synthetic biology standardisation through international collaboration (BioRoboost)
9	Battery design and manufacturing optimization through multiphysic modelling (Defacto)
10	Cloudwatch and Cloudwatch2
11	Contributing to a well-reasoned set of airworthiness standards for mass-market drones (AW Drones)
12	Adapting and maintaining the innovation management assessment tools and support enhancing the innovation management capacity of SMEs (IMP^{3}Rove for Future)
13	WaterSpy
14	5G European validation platform for extensive trials (5G EVE)
15	DigiPrime
16	Cyberwatching.eu
17	BioMonitor
18	Helios
19	Safeway
20	5GZORRO
21	SecureIoT
22	Dynamic spectrum sharing and bandwidth-efficient techniques for high-throughput MIMO satellite (DynaSat)
23	Europlanet 2024 research infrastructure
24	European quality controlled harmonization assuring reproducible monitoring and assessment of plastic pollution (EUROqCHARM)
25	European connected factory platform for agile manufacturing (EFPF)
26	Oleum
27	Privacy and security maintaining services in the cloud (Prismacloud)
28	EfficienSea 2
29	From mobile phones to court – a complete forensic investigation chain targeting mobile devices (Formobile)
30	Standardisation of generic pre-analytical procedures for in-vitro diagnostics for personalized medicine (Spidia4P)
31	Advancing resilience of historic areas against climate-related and other hazards (ARCH)
32	CircThread
33	Cyber security network of competence centres for Europe (CyberSec4Europe)
34	Integrated and standardised NGS workflows for personalised therapy (Instand-NGS4P)
35	Smart mature resilience (SMR)
36	Intelligent data-driven pipeline for the manufacturing of certified metal parts through direct energy deposition processes (Integradde)
37	Being safe around collaborative and versatile robots in shared spaces (COVR)
38	Intelligent open test bed for materials tribological characterisation services (i-Tribomat)
39	European activity for standardization of industrial residual stress characterisation (Easi-Stress)
40	European research infrastructure supporting smart grid and smart energy systems research, technology development, validation and roll out – second edition (ERIGrid 2.0)

Source: Study team.

Practically all the case study projects reflected the opinions of our expert interview partners and the literature. The fact that there is so little deviation from the findings of the desk research and interviews with 40 participants in case studies suggests a rather stable set of elements of good practice across a range of technology fields and different types of projects. Nonetheless, it was possible (a) to identify certain nuances (as well as a small set of additional elements of good practice), (b) to deepen the understanding of several elements of good practice and (c) to better compare the significance of the elements of good practice with each other.

The major takeaways, in terms of backing evidence obtained already from interviews and literature, include the following.

- **The importance of the preparation phase:** In practically all case studies we have observed that most of the success lies in good preparation of the proposal, even though some projects chose to give standardisation a different treatment during the running time of the project by involving SDOs, which was not initially planned (see case study 37). There were projects that had different accounts of whether the planning should be as precise as possible (for example case study 37) or should provide for certain elements of flexibility (see case study 38).

- **The role of SDO involvement:** Several projects opted to involve SDOs as project partners. Those that did saw the SDO involvement as being highly successful and cited the reasons discussed in the literature and interviews as to why engaging SGOs can be beneficial. Those who did not draw on SDOs stated reasons such as that there were already sufficient linkages to TCs; that 'SDOs … need to be open for the wider community and not dedicated to a specific project or consortium' (case study 20); or that otherwise the consortium would have become too large (see case study 7). As an alternative, it is proposed:

  > *If it is not feasible to have a standards agency as a full partner, e.g. because the number of partners in the project … is already significant, then involving individual experts who are associated with standards agencies will be helpful in providing a direct and tangible link that will raise awareness and accelerate the adoption process* (case study 7).

- **The importance of assessing whether there is a real need for standards/standardisation:** Most projects understood from the very beginning that standards/standardisation is an issue for them. A common task was hence to create a standards/standardisation landscape and gap analysis at the beginning of the project. Case study partners made specific remarks in relation to establishing a common understanding of standards (and/or a need for training) and mentioned a need to create a common denominator and strategic understanding within the consortium so that the representatives can negotiate on behalf of the project in relevant standardisation forums (see case study 38).

- **The difficulty in synchronising and matching the rather exploratory research process with the strict and time-consuming standardisation processes:** This was mentioned as a barrier in many project case study interviews. Developing a standard takes significantly longer than the term of a research project. Hence, there is a need for other types of standardisation-related outputs and/or there is the possibility of using strings of consecutive projects to synchronise with standardisation projects (see, for

example, case studies 10, 40). Another option is, where feasible, to have an objective of aligning the project with existing standards (see case studies 7, 9, 15). One operational idea was to operate two parallel calendars (one for research, one for standardisation) and to outline the interrelations between the two in the proposal.

- **Stakeholder management:** This has been identified as one major issue that had to be addressed in many projects and was seen to be of utmost importance when dealing with standardisation (e.g. see case studies 17, 18, 23). It was frequently mentioned that there must be standardisation experience in the consortium and good links to TCs. But – and this is an addition to the interview and desk research evidence – there is much more need to address a wider stakeholder community and, for example, to perform marketing/communication activities (e.g. see case studies 24, 39) to create wider-reaching industry support. Hence, there are also needs to be considered when it comes to communication, marketing, meetings, policy/politics and the necessary time to be spent on these issues. For example, case study 18 illustrated that:

  > *It is extremely important to have strong technical and regular participation in the different applicable standardisation bodies' forums. Each participant has a specific interest (authorities, industrial companies, SAR [search and rescue] forces, standardisation bodies). This requires strong investment in travel, time and expert resources…*
  >
  > *The human factor in all those discussions is a key element and requires meeting the different parties involved face to face* (case study 18).

- **Indicators:** While some areas of clear understanding of how to deal with standardisation could be observed in relation to key performance indicators (KPIs) and other indicators for monitoring and assessing standardisation activities, it became clear that this is a topic where the least amount of experience seems to be present. However, a case study partner also stated that:

  > *One of the referred success factors outlined by the project is the tangible metrics (KPIs) of standardisation activities, including, for example, the number of SDOs and standards targeted and contributed to* (case study 20).

An additional element of practice mentioned, on top of the evidence compiled in the literature and the interviews, was the following.

- **Using specific projects and support structures:** The Commission has set up community support actions (CSAs) to help researchers deal with standardisation (see case study 10). In case study 10, such CSAs can be also a means to sustain some activities beyond the lifetime of the funded Horizon project.

Other challenges were identified on top of those described in the literature.

- A case study project pointed to the **difficulties in accessing full standards due to fees to be paid** and called 'for better links between researchers and standardisation bodies to allow more open access to standards for researchers' (case study 11). This means that at least for this project, or projects needing to access many standardisation documents, fees may be a barrier.

- **Several case study projects reported issues related to IP management in more detail,** mostly in relation to trade secrets and confidential R & D outputs (case studies 2,

9, 38). Keeping information confidential (e.g. for the purpose of commercialisation by a start-up) is at odds with the standardisation process, which requires making information widely available and easy to use by everyone. This requires careful management and a balancing of interests with respect to what to keep sensibly secret and what to provide in a meaningful way to the standardisation community. An interviewee reported, mainly in relation to copyrights, difficulties when applying a fully fledged free and open-source software (FOSS) approach:

> *An important risk factor mentioned was the emergence of de facto standards from the open-source communities, which risk poor governance if a truly FOSS model is applied. Typically, it is common to have reference standards in the network domain because of the truly interworking nature of networks. An extreme FOSS approach can generally lead to high proliferation of redundant solutions and potential high variation of interfaces, protocols and solutions with respect to the more traditional SDO-driven specification initiatives. In fact, the most successful open-source communities working on network technologies adopted specific governance models and membership-based contribution schemes, which make them more like traditional SDOs* (case study 20).

- In terms of sustainability, **active stakeholder management is seen as a key ingredient**. The reasoning is that, by gathering so much interest in project activities, the industry will stay engaged and continue to use the R & D results in standardisation beyond the running time of the project. For example, in case study 39 it says:

> *Through building a community throughout the project, the hope is to reach a critical mass at which it remains somehow self-sustained. Against this backdrop, it is noteworthy that standardisation can help networks that far exceed the reach of Horizon project consortia networks, as evidenced by a South African company that recently got in touch with the research project* (case study 39).

Another way to achieve sustainability is through a start-up whose business model relies on the R & D results of the projects and the standardisation activities undertaken (case study 38).

RECOMMENDATIONS

We structure our recommendations into three major groups: recommendations for university and research organisation management and administration at institutional level (including technology transfer offices); recommendations for researchers / research groups (at individual researcher or project level); and recommendations at policy level and wider stakeholder level. Finally, considerations and recommendations for indicator development will be explored, too.

Recommendations for universities and public research organisations (institutional level)

Recommendation A1: **Develop a standardisation policy, alongside or as part of an IP or R & D results valorisation policy**

Over the past decades, following the push in the United States with the 1980 Bayh–Dole Act, many universities and PROs have developed institutional IP policies that deal with the handling of IP stemming from R & D results, with a view to commercialising and valorising these results. Given that standardisation can be seen as another, not yet fully developed, channel for the valorisation of research results (which also interacts with IP considerations), it stands to reason that standards and standardisation should form part of an integrated R & I valorisation strategy that covers both IP and standardisation. In such a combined approach, the IP strategy part would take standardisation issues into account, while the standardisation part would cater for IP issues (see also the corresponding recommendation B7 for individual researchers / research projects).

To this end, universities and PROs must answer questions about which research fields would be exposed to standardisation, and in what ways (to identify the target group of researchers), and how standardisation can help valorise research results (with all possible advantages, disadvantages and caveats). This means that at institutional level there should be a needs assessment regarding standards and standardisation (at project level, this is the subject of recommendation B1).

We propose a two-pronged approach. Within a university/PRO, an enquiry could be made to all internal research units about their level of possible and actual engagement with standards and standardisation activities (and their level of knowledge of the activities). Externally, universities and PROs should liaise with (national) SDOs, which could inform and champion standardisation as a task in research projects. At universities, the offices most relevant to SDOs are often those of the vice deans responsible for R & D.

The R & D valorisation strategy should, with regard to standardisation, tackle several topics that are also subjects of recommendations A2 to A5 below. As many of these topics are new, it would be also advisable – depending on the outcomes of discussions in WGs – to pilot some of the measures (e.g. only for certain faculties) and to closely monitor them (before rolling them out for the whole university).

Recommendation A2: **Consider standardisation activities and outputs appropriately in the career development plans and research assessment exercises of researchers**

One of the major issues to be addressed in a university policy regarding standards and standardisation for R & D valorisation is to incentivise the standardisation activities of its researchers and make these activities count towards career development. Standardisation follows a similar path to that of IP-based research commercialisation, where activities with

respect to patenting or spin-off creation have had to be considered in career development plans that were typically only based on publication track records (see also section 4.4 on indicators).

Recommendation A3: **Provide for training and teaching on standardisation**

All evidence sources point to rather poorly developed awareness of standards and standardisation among most university/PRO researchers. When confronted with standardisation needs, researchers will most likely train on the job during the research project. Hence, there is a need to address the skills gap in training and lecturing.

- Targeted training should be delivered first to key executive staff at universities, such as vice deans for research, ensuring their support for further development of a standardisation policy in their institutions. Following this, training should then be offered to those researchers who are most likely to be affected by and exposed to the topics of standardisation.

- As part of institutions' standardisation strategies, standardisation should be also considered as a topic for teaching in appropriate business, technology and science programmes. Cases in point could be, for example, innovation management lectures, which currently hardly tackle standardisation issues.

Recommendation A4: **Make technology transfer offices fit for standardisation**

Another tangible outcome of the Bayh–Dole Act was the global proliferation of TTOs tasked with supporting researchers in the valorisation and commercialisation of research results. In Europe, TTOs have over the years established themselves in many universities as service stops not only for handling and filing IP, or supporting start-up creation, but also for providing general support when dealing with contract research and helping to administer collaborative research projects. TTOs are hence another institutional anchor point indicated for supporting standardisation, and their involvement is a logical continuation of their tasks.

TTOs should hence be enabled – e.g. through training and institutional empowerment – to provide a set of services in relation to standardisation, such as:

- provision of basic know-how regarding standardisation needs;

- ability to link to SDOs and their training/service offerings;

- basic support when creating research proposals including in relation to standards and standardisation;

- basic support in the standardisation process when it comes to filling out forms etc. (and/or referral to SDOs for that purpose);

- support when dealing with IP matters in standardisation processes;

- monitoring and reporting of standardisation-related outputs of R & D projects;

- organisation of training.

Recommendation A5: **Develop an indicator and evaluation system**

Finally, universities should start addressing the need for a monitoring system with indicators. Perhaps this is best done in close collaboration with other universities (networks of TTOs) to create common and comparable methods of data collection and interpretation. Given the pioneering character of such activities, we would opt for a more qualitative approach at the beginning. In such an approach, there would be not only data for quantitative indicators defined and collected, but also a clearly spelt out need to have researchers and/or TTOs write self-assessment reports detailing the context of the standardisation activities. This would help in (a) making good interpretations of the quantitative indicators and (b) providing a basis for evidence-based improvements of monitoring and indicator systems (see also section 4.4 on indicator development).

Recommendations at individual researcher/project level

Recommendation B1: **Assess carefully whether and where standards and/or standardisation are really needed in the research project**

At the beginning of the process of drafting a research proposal, there is always a need to assess whether activities in standards and/or standardisation are really needed. Standards and standardisation have been shown to be a powerful tool for valorising research results. However, standards and standardisation activities are not in every case the right way to commercialise research. Standardisation should hence be understood as a tool and not a goal in and of itself. There are several indications of whether standards and standardisation could be a topic to cater for in a research proposal, such as these:

- the call for proposals mentions standardisation and standards explicitly in the call text;
- the research/technology field requires interoperability of different technological parts;
- there are safety, environmental or health issues to be defined and catered for;
- there is a need to develop a common terminology to be used by different stakeholders;
- there is a need to have clearly defined ways of measuring problems;
- the technology field is evolving and (new/amended) standards are needed.

A good starting point to see whether standardisation is a relevant topic or not is the chart from CEN-CENELEC (see Figure 9 above), which shows where standards and standardisation could provide benefits for R & D projects.

Apart from this general understanding of whether standards and standardisation are a relevant issue for a research project, the case study projects also revealed a need to define the scope of the standardisation activities carefully in order to understand where a specific gap in standardisation needs to be addressed. This frequently entails carrying out a gap analysis in standards and standardisation activities, because – as was also shown in many case studies – the landscape of standards and standardisation activities can turn out to be complicated. Hence, if not already clear or performed prior to submission of the proposal, a

standardisation landscape analysis (gap analysis) should be considered as one of the first tasks during project execution. It could be ideally carried out by an organisation familiar with the standards landscape, such as an SDO.

Recommendation B2: **Create a common understanding (i.e. basic knowledge), as well as a common strategic position in the consortium, on standardisation and standardisation issues**

The second recommendation is closely linked to the first, in that researchers should develop a common understanding of the standardisation needs and tasks at hand, once it is established that standardisation is a topic for the proposal. This understanding has been shown in the case studies to be needed at two levels.

- Firstly, researchers must properly understand what standardisation is. As has been shown in the interviews and in the case studies, many researchers with little experience in standards and standardisation confuse work such as publishing a paper, which defines parameters for a research topic in a supposedly common way, with formal standardisation. It is hence important that researchers have and/or obtain a basic knowledge of formal standardisation processes, including the need to achieve, as regards a formal standard, consensus among many stakeholders; to understand the possibilities and limitations of standardisation-related deliverables such as reference and specification documents (CWAs, DIN Specs, etc.); and to understand the processes leading up to these deliverables, including their requirements and strict timing.

- Secondly, besides having a common understanding of the processes behind standards and standardisation, consortia should also define a common strategic position regarding the planned standards and standardisation activities. Once consortium members act on behalf of the project in the different WGs and standardisation forums, they should have the backing of the various consortium partners and avoid situations where different consortia partners contradict each other. This entails finding common denominators regarding technical features to be developed further in the standardisation activities.

Recommendation B3: **Make standards a tangible component in the proposal and project**

All sources of evidence point to the need to make standards and standardisation a tangible component of a research proposal and to avoid situations of ‘standards-washing’. The reason for that is also rooted in the strictness and complexity of the standardisation processes, which must also happen in clearly defined time frames. This quickly leads to questions of how to achieve the standardisation-related goals, and the ‘how’ needs to be as detailed as possible.

Against the backdrop, making standardisation tangible translates into WPs and/or tasks dedicated to standards/standardisation that clearly spell out what is to be done in terms of standardisation. Underpinning these activities with budgets, time resources and responsibilities is more likely to ensure that the planned activities are carried out.

However, while some of the case study projects and evidence sources want to have the standardisation activities spelled out in as much detail as possible in a proposal, others call for more flexible approaches that allow some activities to be defined in greater detail during the running time of the project. Cases in point are (a) when IP might be developed (including trade secrets) and there is a need to decide flexibly which type of information is to be shared

in standardisation activities and (b) planning for contingencies, should the standardisation activities not go as planned (e.g., if one TC rejects the ideas coming from the research project, there might need to be the possibility to revert to another TC).

Recommendation B4: **Involve partners with standardisation experience in the team, with good access to the standardisation community**

Perhaps one of the strongest recommendations concerns the need to have partners in the consortium with standardisation experience who also have good access to the standardisation community. Ideally, such partners should already be on board from the start. Most importantly, there need to be good links to the TCs, which in the end take the decisions on ongoing standardisation activities. Ideally, researchers in the consortium should hence also be members of the relevant TCs (best of all, even chair them).

If this cannot be achieved from the start, alternatives might be to involve TC members (or active standardisation specialists) as sounding boards for the project. Yet another option would be to involve SDOs as project partners or subcontractors in the consortium. Several case study projects have shown considerable benefits using this approach, including governing the standardisation processes in the project with intimate knowledge of the necessary forms to fill out and timelines to observe, the creation of standardisation landscapes, the identification of relevant TCs and WGs, and the forging of links with these groups, including the organisation of events. To this end, it is notable that some (but seemingly not all) SDOs have been developing this kind of research project support as business cases for themselves. They hence offer relevant services – including up-front information material – proactively.

With this in mind, another important activity is the provision of training and awareness raising for all consortium members who are not highly familiar with standards and standardisation. Mirroring recommendation A3, awareness raising and training could also be offered by SDOs specifically to researchers as part of project activities.

Finally, it should also be remembered that SDOs are not researchers and, as in standardisation, play more of a facilitator role. Some experts and case study projects opined in this context that the most important part is to have good links established to the TCs and WGs, and, if this can be already guaranteed through the relevant backgrounds of researchers involved, having additional facilitation and guidance through an SDO might not be necessary.

Recommendation B5: **Invest in and cater for stakeholder management throughout the project**

Along with the preceding recommendation, B4, this recommendation reflects one of the major findings of the study, namely that a large proportion of standardisation activities translate in practice into stakeholder management. The reason for this is the need in standardisation processes to reach consensus – or, when it comes to reference/specification documents such as CWAs, to have at least some level of stakeholder support for the standardisation ideas. On the positive side, the wide cast of stakeholders also provides for considerable networking possibilities, extending well beyond the Horizon research community.

In practice, stakeholder management means that, apart from technical and linguistic skills needed for standardisation, there is a need for negotiation skills and a talent for policymaking and agenda setting. As negotiation rounds are lengthy, there is also the matter of perseverance to be considered. Diplomacy is yet another skill needed, as is the ability to round up support for a project's cause and ideas (not only in the standardisation discussion

forums, but also in bilateral talks outside the immediate meetings). Not to be forgotten are skills such as the ability to understand the needs of other stakeholders and networking.

Against this backdrop, four areas of action can be identified.

- **Ensuring industry involvement:** Regardless of the kind of contributions to standardisation (whether this is a full-grown standard to be amended or developed further, or an intermediate step such as a CWA), there is a need to have as much industry backing as possible – not only for the standardisation activities to succeed, but also generally to ensure uptake and wider-reaching commercialisation of the innovations developed. Industry involvement can be from the start in the form of having relevant industry payers in the project consortium, or by ensuring uptake by substantiating the proposal in terms of standardisation activities with letters of intent.

- **Implementing a good marketing and communications policy:** What has been said in relation to the preparation of a proposal in the preceding bullet point is also a need to be addressed throughout the running time of the project. Hence, the advice is to develop a dedicated marketing and communications plan in relation to standardisation activities. In this regard, some case study projects have reverted to measures such as dedicated websites, mailing lists or series of webinars specifically designed for that purpose.

- **Training for negotiation skills and policy work:** For many researchers who are not familiar with standards and standardisation, stakeholder management may be a new area of activity. Therefore, training in this area (e.g. negotiation skills, policy work) may need to be considered.

- **Resourcing:** Stakeholder management is a time-consuming activity, the extent of which can be surprising to researchers inexperienced in this matter. Hence, sufficient time and resources need to be allocated for these activities.

Recommendation B6: **Be realistic about outputs, outcomes and impacts – consider appropriate key performance indicators**

One major finding concerning standardisation activities in a funded research project is that the (more exploratory) research processes and the (stricter) standardisation activities are difficult to synchronised, as evidenced by several case study projects. Moreover, there is consensus in practice that it is next to impossible to come to a new (or revised) standard within the time frame of a research project. This calls for realistic approaches to what can be achieved standardisation-wise within a Horizon project. Hence, for many projects, striving for a new standard may not be the best or even a feasible option.

The following options can be considered instead.

- **Portfolios/strings of projects:** While it is hardly possible to support the definition of a standard substantially within a single Horizon project, there are success stories where this has been achieved with a string of research projects (i.e. projects that have predecessor projects) and/or using synergies with other funded research projects that run in parallel. To the extent that the realisation of project strings/portfolios is realistic and feasible, this approach could be strategically shaped for developing new standards with the support of Horizon funding.

- **Contributions to standardisation using intermediate contributions (reference documents and specifications):** If developing a new standard as whole is out of reach, because it is too difficult to reach consensus in the communities within the available time, consortia can strive for standardisation documents that do not need full consensus, for example reference documents and specifications such as CWAs and DIN Specs. Consortium members should make themselves familiar with the advantages and disadvantages of these tools (and, again, make themselves aware that the overall aim is to gather as much industry support behind these specifications as possible, not the specifications per se). While these types of specifications are specifically advertised by SDOs for funded research projects, our project case studies have revealed that even more short-term outputs should be considered, such as the establishment of new WGs and new work item proposals. In addition, contributions to standardisation developments (such as participation in WGs and meetings) and the level of support by industry (as measured, for example, through voting behaviours) can be considered.

Against this backdrop, it is also important to consider the development of KPIs that take the aspect of realistic outputs, outcomes and impacts into account. This also mirrors at project level recommendation A5 above (see also section 4.4 on indicator development).

Recommendation B7: **Take standardisation issues into account in IP management and strategy (and vice versa)**

Defining standardisation outputs and impacts can usually not be done in isolation from other activities to commercialise R & D results. Because many such commercialisation activities – including different licensing models (and also open-source licences) and the creation of start-ups – involve strategic considerations regarding the use of IP, IP issues must thus be considered in conjunction with standardisation when defining a proper commercialisation strategy.

This relates mostly to three types of IP: patents, copyrights and trade secrets. The first extends into areas such as SEPs, where decisions must be reached such as whether certain patents should be made accessible under fair, reasonable and non-discriminatory conditions. This would be a new standard to be implemented using a patented technology developed or used during the R & D project. In terms of the second type, copyright and licensing conditions for software could be an issue (including the use of open-source software). The project case studies have also shown the need to deal with trade secrets as the third relevant IP instrument. This is a particularly interesting observation, since, more than the other two instruments, trade secrets are at odds with the general principle of standardisation, which is sharing knowledge and making things accessible to everyone.

Overall, IP management must ensure that the different assets are protected and shared / not shared in context-specific ways considering standardisation obligations. These considerations at project level should be also informed and guided by the university's or PRO's institution-wide general IP and standardisation policy (see recommendation A1).

Recommendation B8: **Ensure sustainability beyond the running time of the project**

To create impact, particularly in relation to standardisation activities that extend beyond the time frame of a Horizon research project, it is necessary that research results be sustained

beyond the running time of the project (and even if project participants leave for new jobs). The following options have been suggested.

- Having official specification and reference documents such as CWAs can increase the chances that the standardisation-specific research results are sustained in the future. This is due, on one hand, to the official character of such documents, which makes them easily retrievable in standardisation communities. On the other hand, SDOs also have a sort of repository function so that the documents also stay accessible over prolonged periods.

- Beyond the maintenance of project websites and using document repositories for things such as technical reports, an informal way to secure sustainability is to ensure a sufficiently high level of industry interest. The logic is that, if industry is really interested in the standardisation work undertaken, it will itself take the initiative and keep the project activities alive. This is again a rationale for intensive stakeholder engagement during the running time of a project.

- Follow-up projects may be another way to ensure sustainability in the standards development process.

Recommendations at policy / wider stakeholder levels

Recommendation C1: **Have the European Commission engage with SDOs and (European) university associations as well as associations of technology transfer offices (e.g. the Association of European Science and Technology Transfer Professionals)**

To have researchers and research organisations pick up on the recommendations in Sections 4.1 and 4.2, it is imperative that action also be taken at policy levels with different stakeholder groups. In this context, we see foremost a need for the European Commission to liaise with SDOs, associations of universities (and of other types of research organisations), and associations of technology transfer offices and professionals (notably the Association of European Science and Technology Transfer Professionals (ASTP)).

Winning associations such as the ASTP over to the standardisation code of practice provides an additional channel through which to reach out to universities and research organisations and to champion the cause Europe-wide. The latter aspect allows harmonisation of approaches across Europe as well as the exchange of experiences.

Specific activities that could be tackled through this collaboration are, for example establishing WGs for the harmonised development of indicators to track knowledge valorisation with standards; the collection and reporting of the data; elaborating principles by which IP management and policies can be aligned with standardisation activities; offering training and awareness-raising activities (for researchers, but also for TTOs); developing specific support services to be provided by TTOs to researchers (also including referrals to SDOs for specific types of services); elaborating on ways in which research performance assessment can take standardisation activities into account; and evaluating the feasibility of establishing a standardisation helpdesk similar to the already existing European IPR Helpdesk.

Recommendation C2: **Have SDOs further develop their service portfolios for R & D projects and examine further possibilities to synchronise standardisation with R & D better**

The study has shown that SDOs can play a pivotal role in fostering the use of standards and standardisation in the knowledge valorisation of research projects. To this end, many SDOs have already developed several offerings, including dedicated brochures/websites, partnering offerings, and prizes for successful use of standards and standardisation. However, it seems that these activities (which should be continued and developed further) have focused more on individual projects and the researchers involved. In line with recommendation C1, we first recommend that SDOs extend their outreach and service activities to other units and stakeholders within universities and PROs. This refers particularly to the offices of vice deans responsible for research at the universities, to TTOs and to the equivalent units in PROs.

Furthermore, many inputs received from the case study projects indicate that researchers also have a wish list for SDOs and the standardisation community. Accordingly, SDOs should evaluate whether there are ways, particularly in early phases of standardisation, to make the standardisation processes more flexible and hence easier to synchronise with from the research side. Another point to elaborate could be to assess possibilities by which authorship and contributions to standards creation by researchers can be better tracked (which is important for measuring research performance in a setting where citations are a major KPI). Finally, training and awareness raising should continue to be offered to researchers and explained in greater detail, such as what are the advantages and disadvantages of 'standards-light'-like/pre-standard outputs (CWAs etc.).

Recommendation C3: **Examine, in particular, small and medium-sized enterprises' needs in collaborative research in relation to standards and standardisation**

While SMEs were not the focus of the study, they appeared from time to time in the case study projects as either a topic of discussion (e.g. when a start-up activity related to the Horizon project was described) or (seldom) in a leading role in a consortium. Hence, a recommendation is for future studies to examine in particular the role of SMEs in Horizon projects, specifically regarding their use and exposure to standards and standardisation topics. This is because of, on the one hand, the significant role SMEs play in innovation but, on the other hand, notable issues such as a lack of awareness and resources (time and money) as well as their having potentially less leverage in TCs than large firms. In this context it would also make sense for the European Commission (and SDOs) to seek collaborations with leading SME associations. Overall, this could also lead to specific actions, such as an SME-tailored/SME-specific standardisation booster.

Recommendation C4: **Address the Member State policy level and national Horizon support structures**

Outreach activities for the code of practice would not be complete if there were no activities (by the European Commission and/or SDOs) targeting the Member States. Two types of institutions stand out here as target institutions. Firstly, the national ministries in charge of education and research could champion the topic of standardisation and standards, such as when negotiating performance contracts with universities. Secondly, national support structures aim to help researchers in their efforts to participate successfully in Horizon projects. Overall, the establishment of a national contact point for standards and standardisation could be considered, too, akin to the already existing national contact points for the thematic areas of Horizon Europe.

Recommendations specifically with respect to indicator development

Recommendation D1: **Push for the development of an evidence base regarding viable sets of indicators to be used for performance assessment of R & D in relation to standardisation activities**

One of the major findings of the study is that the development of indicators to track the valorisation of research results with standards and standardisation is in its infancy, and the relevant body of evidence is only just starting to develop. Against this backdrop, the case study projects defined KPIs, if at all, in a very hands-on manner.

The situation is similar to the early days of the Bayh–Dole Act, when the technology transfer debate about using IP as a major valorisation channel ignited and the benefits and disadvantages of using indicators such as the number of patents filed through R & D projects became the subject of considerable scrutiny (with final conclusions still not reached). The challenges are also strikingly similar. Using patents or the number of licence agreements as KPIs is easy because these indicators can be easily collected. However, just applying for patents without good commercial prospects is seen as counterproductive. While indicators such as the number of patents applied for therefore have their limits, they are still regularly collected for monitoring purposes, albeit to be interpreted only in wider contexts.

The same would potentially apply to standardisation-related outputs, for which different single indicators also have different and plentiful limitations.

- The number of pre-standard reference documents and specifications such as CWAs (as well as other outputs, such the more short-term new work item proposals) look as if they are sensible output and outcome indicators. However, like patents, they are not a direct measure of actual valorisation and commercialisation, as CWAs may end up not being used. Even the adoption of a standard – a straightforward-looking indicator, but not realistic for a single Horizon project because of the time it takes to develop – may not be sufficient for successful commercialisation, as they may end up not being used either.

- CWAs and other pre-standard reference documents may also have other specific disadvantages, such as that CWAs must not contradict standards. These subtle aspects also need to be factored in when using such variables as indicators.

- An important issue is how to track individual researchers' contributions to standards and standard development. In contrast to patents and scientific publications, it seems that the concept of authorship is not widely implemented, making it more difficult to track impact using citation measurement techniques.

Taken together, this points to the following needs: firstly, to build up an evidence base regarding the pros and cons of certain standardisation-related indicators; secondly, and most likely, as in the area of IP, to draw on a set of indicators rather than single indicators.

Recommendation D2: **Strive for combined qualitative and quantitative performance reporting for evaluations and monitoring**

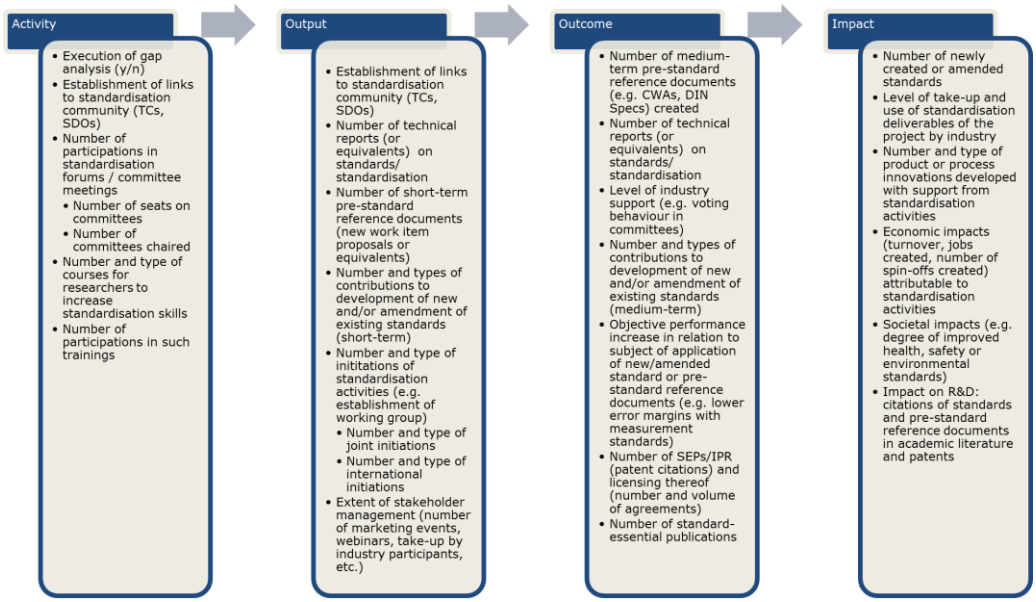
Continuing from recommendation D1, a third need is to observe contextual factors in appropriate ways. Against this backdrop, and given the current low evidence base, we believe that combined qualitative and quantitative reporting on indicators for assessing valorisation

performance might be warranted: indicators should hence be defined and the corresponding data collected, but, instead of simply relying on indicator values, emphasis should be placed on qualitative reporting and interpretation of the indicators, such as in the form of (self-)assessment reports.

Figure 16 provides a list of potential indicators (as used by the case study projects) and a suggestion of which level of the impact pathway / logic framework to use to measure the indicator, as a basis for further discussion. The outcome level is chosen such that the outcome can be achieved within the running time of a Horizon project. It also incorporates the suggestions made by Blind (2019; see also literature review). The indicators will, in all likelihood, need to be specified further in the context of specific research projects.

Figure 16 Potential indicators to track valorisation and commercialisation of R & D activities using standards and standardisation

Source: Study team, also incorporating suggestions from Blind (2019).



CONCLUDING REMARKS

This study examined the use of standards and standardisation in Horizon research projects and singled out several elements of good practice when dealing with standards and standardisation. Recommendations were outlined for researchers / research projects (project level), for universities and research organisations (institutional level), for policymakers and the wider stakeholder community, and for indicator development. The 40 project case studies developed for this assignment were the major source of evidence and can also be used for reference purposes by researchers and various other stakeholders.

One of the first findings was that the different sources of evidence align well with each other, with few contradictions and with mutual support of the arguments delivered. The most significant challenge is to understand and synchronise the two worlds of exploratory research and strict and lengthy standardisation processes. While suggestions for possible performance indicators for monitoring and evaluation purposes were discussed, overall the development of indicators is in its infancy.

Major take-aways include the fact that standardisation has to be considered, following a needs and gap analysis, as an important channel for the valorisation and commercialisation of R & D results (with the observation that this understanding is rather new in the realm of R & D commercialisation and valorisation); the need to cater for standardisation issues, particularly in the planning and proposal phase, especially in relation to avoiding 'standards-washing' and catering for clearly defined tasks and WPs; the need to have close links to TCs; the observation that standardisation activities translate in practice into compelling needs for stakeholder management and engagement activities (covering activities such as lengthy negotiations, policymaking and agenda setting, and outreach and marketing); the need to carefully consider the interplay of IP and standardisation issues; and the important role of know-how with regard to standardisation processes.

Success in terms of valorising research results through standards and standardisation seems to be also contingent on framework conditions and factors that were outside the scope of the study and could be tackled only partially if at all. This includes issues such as the specific role of SMEs in the context of Horizon projects and their specific exposure to the topic of standardisation. These are, hence, also subjects in need of further research.

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ANNEX 1 – METHODOLOGY

The main objective of the phase 1 analysis in this study was to discover best practice examples out of a large number of projects, as shown in **Error! Reference source not found.**.

To inform the analysis of the survey data, a literature review as well as scoping interviews was used.

The aim of the **literature review** was to assess the level of knowledge of good practices in dealing with standards and standardisation in research projects and the role that standards and standardisation play in the commercialisation of R & D results.

The literature analysis started by searching relevant databases such as Science Direct, Web of Science and Google Scholar for papers and publications on the study topic. A search strategy was defined by using a combination of search keywords such as 'standards', 'standardisation', 'standardization', 'technology transfer', 'knowledge transfer', 'R & D projects' and 'commercialisation'. More precise keywords were used to narrow down the search. These included 'success factors to standardisation in Research & Innovation projects', 'standardisation in H2020 projects', 'standardisation as a valorisation channel', 'key success factors for standardisation in knowledge valorisation', 'standardisation as a channel for knowledge valorisation', 'key elements of successful research valorisation' and 'from research valorisation to standardisation'. One other clear source of information that we used and assessed was the published data from the German Standardization Panel ([48]). Besides academic literature, we also analysed grey literature, including publications of national and international SDOs, policy papers, research reports, guidelines for researchers and already available best practice examples (testimonials, case studies).

The resulting set of papers was screened by examining the abstracts for relevance. Only the subset of relevant papers was considered for inclusion in this study. For a full list of the literature reviewed, please see the bibliography.

In parallel with the literature review, we conducted **interviews** with five standardisation experts (see table 3) who have insights into the Horizon-funded R & D projects with strong standards/standardisation components. In selecting the experts, the focus was on finding expert members of SDOs involved in relevant projects, but particularly also (SDO) project members of the Bridgit and Bridgit 2 projects. The latter were expected to already have a good idea of what constitutes best practice, having looked into a number of R & D projects already.

([48]) https://www.normungspanel.de/en/

Table 3 A list of interviewees

Name	Job title / organisation
Karl Grün	Director of development, Austrian Standards Institute (written input)
Mario Beier	Head of Group Research and Transfer, DIN (German Institute for Standardisation) (written input)
Fernando Utrilla	Head of Research and Innovation Unit, Spanish Association for Standardisation
Janne Kalli	Technical adviser, Finnish Standards Association
Knut Blind	Chair of innovation economics, Faculty of Economics and Management, Technical University of Berlin Business Unit Innovation and Regulation, Fraunhofer ISIS

When approaching the survey analysis, first of all, in order to find the best out of a multitude of cases, a few major influencing criteria had to be found, which promise to predict the success of an innovation project. These criteria were (1) deduced from external sources (such as literature, experts and awards) and (2) systematised along the empirical framework, and served as (3) selection criteria to identify good or best cases.

- Then, the success criteria found were compared with the questions in the survey, to determine which success criteria can be used for selection. Firstly, the survey questions were categorised according to the segments of the empirical framework (4) and then matched with the deduced success criteria (5).

- By applying these success criteria to the dataset, a pre-selection of best practice cases could be found (6).

- After the best cases were identified, interviews and further data analyses could now be used to determine which special characteristics and measures of these projects made them so successful (7). New and deeper insights will continuously expand our findings. Using a feedback loop (8) helps to refine success factors and to optimise the final selection of best cases.

Detailed analysis for selected questions to single out best practices
To better describe the process of singling out best practices, **Error! Reference source not found.** presents a systematic approach to singling out the projects from the survey that are more likely to be good practices.

Due to the large number of questions in the survey, it was useful to first obtain an overview of the questionnaire. For this purpose, the questions were assigned to the process steps of the empirical framework (1). The framework has proven its effectiveness in its application. It is based on the set-up and existence of a project and follows the project phases. However, particularly beneficial elements are highlighted and listed separately as general success factors. Four segments were distinguished:

1. project history / project concept

2. project implementation / project management

3. project outputs and impacts

4. general success factors.

This framework follows benchmarking assessments performed by study team members in adjacent policy areas, notably the benchmarking support services and projects aiming to foster IP usage by firms ([49]). It has also proved useful for the systematic analysis of best practice Horizon projects in relation to their ways of dealing with standardisation.

Following this, a large number of elements of good practice were retrieved and collected from different sources. This process included the evaluation of the specialist literature. Experts were interviewed, and project descriptions of CEN-CENELEC's Standards + Innovation Awards winners and nominees were consulted. This resulted in a broad spectrum of criteria (2). In addition, the criteria have been sorted in accordance with the empirical framework (3).

In order to distil the most important contributory factors, if criteria were mentioned several times or explicitly highlighted by experts, we distinguished them as major criteria (4).

The next step was to check whether the questionnaire actually inquired into these major criteria (5). Here, for some criteria, we found full coverage (e.g. for the criterion of contact with TCs) or partial coverage. If there is not even partial coverage, this criterion cannot be used for the selection of the best cases within the pool of survey respondents. However, it will still be part of the elements of best practice and can be highlighted and scrutinised in the course of the interviews with projects selected as case studies exemplifying good practices.

The comparison of the questions of the survey with the criteria mentioned in the expert interviews and the CEN-CENELEC awards is presented in Figure . As can be seen from the figure, many of the success criteria identified can still be used to select best practices, because there are corresponding questions in the survey. Overall, the objective was to see what kind of elements of good practice – as identified in the literature, expert interviews and CEN-CENELEC awards – could also be found in the questionnaire for the survey. We did that by matching individual questions of the survey with information from the three other sources of evidence, hereby highlighting instances where the survey could deliver evidence underpinning the findings of the three sources. For example, the change in level of readiness (question 3.5) was mentioned in expert interviews as one factor likely to distinguish a better-performing framework programme project (in terms of standardisation) from a weaker performer. Hence, that question was marked in red writing (indicating a possible element of good practice in the project implementation stage) in the table for further analysis (Figure 17).

([49]) Radauer, A., Streicher, J. and Ohler, F. (2007), *Benchmarking national and regional support services for SMEs in the field of intellectual and industrial property*, Publications Office of the European Union, Luxembourg.

Figure 17 Comparison of survey questions and success factors named in expert Interviews, literature and the CEN-CENELEC Standards + Innovation Awards

Survey			Literature review	Expert interviews	CEN-CENELEC award	Relevance (1 – 2 – 3)
Organisation and consortium						
2.1		Project number				
2.2		Coordinator – type of organisation				1
2.3		other …				
2.4		Project members – type of organisation				
2.5		other …				
	2.4a	Number of consortium members				1
2.6		Project members – countries				
2.7		other …				
	2.7a	Number of countries				1
Project						
3.1		Horizon 2020 – thematic section				1
3.2		Key domain				1
3.3		other …				
3.4		Type of action				1
3.5		Level of technological readiness at start and end				1
	3.5a	Change in level of readiness				1
3.6		Project generated new services/products on the market				2
3.7		specify …				
Collaboration with SDOs						
4.1		Liaison with SDO, NSB, TC				3
4.2		specify …				
4.3		Stage at which collaboration begins and expectations				1
4.4		SDO, SNB, TC are part of consortium				1
4.5		Way of selecting SDO, SNB, TC				
4.6		Contribution of SDO, SNB, TC to methodology				1
4.7		Impact of SDO, SNB on technological choices				1
4.8		specify …				
4.9		Collaboration with SDO, NSB outside the project				2
4.10		specify …				
4.11		Degree of involvement of standardisation entities				1
4.12		Type of involement of SDO, SNB, TC				1
4.13		Contact with CEN-CENELEC or ETSI				
4.14		specify …				
4.15		other …				
4.16		Difference in collaboration with European and non-European SDOs				
Addressing standardisation						
5.1		Importance of standardisation for project				
5.2		Form of dealing with standardisation in project				2
5.3		…				1
5.4		Consortium members were against implementing standardisation activities				2
5.5		Initial reasons for addressing standardisation in project				
5.6		other …				
5.7		Time when standardisation activies were implemented				
5.8		Risks from standardisation-related activites				
5.9		other …				
5.10		Standardisation activities led to follow-up actions				2
5.11		specify …				
5.12		Standardisation activities led to specific deliverables				2
5.13		Nature of deliverables				2
5.14		Reasons for lack of outcome				
5.15		Standard addressed by project				
5.16		Overall costs related to standardisation activities				
5.17		Difficulties or barriers during standardisation activities				
5.18		specify …				
5.19		Disadvantages of standardisation activites				
5.20		Patented or patent pending technologies are proposed in standardisation process				1
Use of existing standards						
6.1		Project included review or assessment of existing standards				
6.2		One or more existing standards have been identified and used				1
6.3		…				
6.4		Description of the use of existing standards				
6.5		Level of importance of the use of existing standards for project success				1
6.6		Degree of improvement by using existing standards				2
6.7		other …				
6.8		Impacts on innovation (in short or medium to longer term) by using existing standards				3
6.9		other …				

New or revised standards					
7.1	Project helped develop a new or revised standard				1
7.2	Supporting development of new or revised standard is project goal				3
7.3	…				1
7.4	Details of proposed new standards or revisions				
7.5	Forms of dissemination standard proposal				1
7.6	Reactions to standard proposal				
7.7	Project directly contributed to development of new/revised standard				
7.8	New or revised standard is in development, is finalised or published				1
7.9	specify …				
7.10	Benefits of standardisation for valorisation of project results				2
7.11	other …				
7.12	Benefits of standardisation for market uptake of project results				2
7.13	other …				
Best practices					
8.1	Project is useful example for best practice case				1
8.2	Future research projects will integrate using, proposing or developing standards				1
8.3	…				
8.4	specify …				
8.5	Changes in the future handling of standardisation in R&I projects				
8.6	specify …				
8.7	Best stage to integrate standardisation in R&I projects				
8.8	specify …				
8.9	Actions strengthening links between research, innovation and standardisation				
8.10	Readiness to cooperate in best practice research				
8.11	Contact details				
8.12	Comments				
8.13	Free text				
8.14	Possible cooperation with ISO, IEC, ITU				

IEC, International Electrotechnical Commission; ISO, International Organization for Standardization; ITU, International Telecommunication Union.

Multiple references to a good practice criterion in literature, interviews and the CEN-CENELEC awards point to a significant indicator (6). All criteria that have been named in at least two areas are considered to be evidence of a particularly good project.

Two types of criteria can be distinguished: exclusion criteria and bonus criteria. Exclusion criteria (minimum criteria) must be fulfilled to be considered for selection as a best practice case. Hence, these criteria are hard selection criteria. One of these criteria is 5.12 ‘Standardisation activities led to specific deliverables’. Only projects with proven standardisation results can serve as role models. If they miss out on any of these criteria, they cannot be considered good practices.

Another category of indicators also leads to exclusion: formal criteria (e.g. 5.4 ‘Consortium members were against implementing standardisation activities’ or 8.10 ‘Readiness to cooperate in best practice research’). Projects that indicated in their responses that they would not be available for follow-ups and to support us in, for example, case study development, also had to be excluded up front.

In addition, if the importance of a criterion is confirmed by the literature, the interviews and the awards, it is considered a minimum criterion. Furthermore, a particularly large number of nominations within an area can also make criterion a minimum criterion. This approach results in the list of criteria in Figure .18.

Figure 18 Exclusion criteria

Exclusion criteria
• Standardisation activities led to no specific deliverables
• No contact with TCs
• Consortium members opposed implementing standardisation activities
• Project members do not think the project would be a useful example

Filtering projects according to these criteria reduced the number of cases to 104. To bring the number of projects down to 40, we then chose to use a scoring model. Successful use of standardisation can be demonstrated in different ways: a published standard, a workshop agreement or possibly just the use of existing standards. It depends on the type of project. To avoid unequal treatment, (bonus) points are awarded for both the use and the development of standardisation elements (Figure). Again, criteria were chosen that were mentioned several times in the literature, interviews or the awards.

These criteria are softer – hence, if the projects perform well in any of these criteria, they obtain extra points; if they do not perform in the criteria, they obtain zero points (but are still part of the set of projects considered as displaying elements of good practice).

In order to select the 40 projects that were most likely to be examples of good practice, the projects were ranked according to the bonus points, and the top 40 projects were selected.

Figure 19 Bonus points

Criterion	Question	Scoring rules	Score project 951972 (1)	Weight (%) (2)	(1) × (2)
Delta TRL (*)	3.5a	For each additional TRL (= +1/9) = +0.11	0	14.3	0.00
New services or products	3.6	New service exists = +1	0	14.3	0.00
CWAs delivered	5.13	CWA(s) exist(s) = +1	1	14.3	0.14
Benefits of using standards	6.6	Benefit exists = +1	1	14.3	0.14
Impacts of using standards	6.8	Impact exists = +1	1	14.3	0.14
New or revised standard is project goal	7.2	Standard is definitely project goal = +1, possibly project goal =+0.5	0	14.3	0.00
CEN-CENELEC award	A1	Winner = +1, nominee =+0.5	0	14.3	0.00
				100.0	**43 %**
					Total score / bonus points
					(= 3 of 7 possible bonus points)

(*) TRLs can have values from 0 to 9. If a firm starts at TRL3 at the beginning of a project and can reach TRL6 at the end, we have an increase of 3 levels. Starting with no TRL (= 0) and working toward level 9 will bring the maximum increase of 9 levels. If the TRL rise is zero the project will be given no extra score (0 %). A rise of 9 levels will be rewarded with 100 %.

The calculation of the project score (= additional points) of project 951972 goes as follows.

Project 951972 did not increase the technical readiness level (criterion score: 0). It also did not generate a new product or service (criterion score:0). But it did develop a workshop agreement (criterion score: 1), and there were benefits through the use of existing standards (improved understanding of current state of the art, improved efficiency of the project activities, improved quality of outputs, etc.) (criterion score: 1). Moreover, the knowledge of

existing standards had a broader impact (e.g. improved design of products, faster or easier market access, improved interoperability of products) (criterion score: 1). The project did not develop a new or revised standard (criterion score: 0) and was not nominated for a CEN-CENELEC award (criterion score: 0).

There are no valid arguments that one criterion is more important than another; therefore, equal weight was given to all criteria. So, for each criterion, we get a weight of 1/7 = 14.3 %. In the next step, the product of all criteria scores and the weight was computed and summed up. This gives a total score of 43 % or 3 out of 7 points.

To determine the stability of the result, simulations (Figure 20) were carried out with other criteria and compared with the original selection. Here, sufficient stability of the result could be shown.

Figure 20 Simulation results of different use of criteria

	Original selection							
TC		■	■	■				■
CWA			■	■	■		■	
STD				■		■	■	■
Combination	1	2	3	4	5	6	7	8
Cases changed	13	4	0	4	13	16	15	3
%	**32.5**	**10.0**	**0.0**	**10.0**	**32.5**	**40.0**	**37.5**	**7.5**

CWA, workshop agreement; STD, standard; TC, technical committee.

Figure 20 shows that the use of other combinations of criteria leads in many cases to a slightly different selection of cases. If, instead of the original selection, cooperation with a TC and the development of a standard are taken (combination 8), three cases (7.5 %) are changed.

The maximum rate of change is 40 %. In this combination, however, the criterion ‘cooperation with a technical committee’ is omitted. Since it is a minimum criterion, the change in case selection is stronger.

It is important to add a methodological note. While we attempted to apply selection criteria based on the different sources of evidence as stated, there still is a certain degree of freedom/discretion that can be applied when selecting elements of good practice. We attempted to balance our selection across the criteria, but we did not use weighting on the factors after we applied our exclusion criteria. In any case, the selection process can be easily adapted by (a) allowing for different points/scores in the scoring model and (b) also adding additional criteria.

ANNEX 2 – CASE STUDIES

Case study 1: Project no 723600 Standards for hybrid manufacturing (Large additive subtractive integrated modular machine (Lasimm))

CORDIS: https://cordis.europa.eu/project/id/723600

Project website: https://www.lasimm.eu/

Start date: October 2016

End date: 30 September 2019

Technology field: AM

Horizon programme line: research and innovation action (RIA): H2020-EU.2.1.5.1. – Technologies for factories of the future

Keywords: large-scale hybrid manufacturing; additive manufacture, machining, cold-work, metrology and inspection; robotics

Project and standardisation element in brief ('abstract')

Over 36 months the Lasimm project developed a large-scale flexible hybrid additive/subtractive machine based on an easily scalable modular architecture. The machine features capabilities for AM, machining, cold-work, metrology and inspection. It is designed to be capable of providing the optimum solution for the hybrid manufacturing (HM) of large engineering parts of high integrity such as those needed by the aerospace, construction and wind power industries. To meet its objectives the machine incorporates several different technologies including wire + arc AM for the additive process, robotics machine architecture to provide capability for parallel manufacturing, and parallel kinematic motion robotics for the subtractive step in component surface finish and accuracy, as well as managing the cold-work needed to ensure that final material properties are better than those of forged materials. The implementation of parallel manufacturing is extremely challenging from a software perspective, and a key part of this project was the development of ICT infrastructure and the toolboxes needed to programme and run the machine.

The project primarily focused on AM standards and contributed to a total of 12 standards. Of particular note are ISO/ASTM PWI 52926-1 Additive manufacturing – Qualification principles – General qualification of operators and ISO/ASTM PWI 52926-5 – Additive manufacturing of metals – Qualification principles – Qualification of operators for DED-Arc.

With regard to HM, the consortium made a recommendation to create a new joint WG in ISO/TC 261 jointly with another TC related to machining and subtractive technologies (e.g. ISO/TC 39 – Machine tools).

Finally, a new International Organization for Standardization (ISO) joint group was created with the aim of developing standards to qualify personnel involved in directed energy deposition by wire arc (DED-Arc) considering several materials and types of equipment used by industry.

What the project is about

Traditional machines have normally been focused on only a single type of manufacturing process, but a new generation of machines is emerging that combine the features of individual manufacturing processes into a single platform.

Developing a new machine concept and design into a single set-up for processing and process control has become an important need of many industries including aerospace, construction and wind power. In direct response to this need, the Lasimm project developed a large-scale flexible hybrid additive/subtractive machine based on a modular architecture that is easily scalable. The machine features capabilities for AM and machining. The machine is also capable of using other functionalities, such as cold-work, metrology and inspection, that have proven to be good add-ons for specific applications.

AM is a relatively new field, and it is important to develop associated standards to reduce/prevent risks, e.g. of the development of mechanical faults (cracks) in large parts, and help to improve repeatability and high process efficiency, e.g. for metal AM, in powder bed fusion technologies such as selective laser melting and electron beam melting. When the Lasimm project started, standards in AM were taking their first steps of development, and specific standards for DED-Arc (also known as wire + arc AM) did not exist at the time. Addressing the standards gap was a significant part of the project. In addition, due to the type of activities carried out during Lasimm, it was also possible to identify standardisation needs in HM and to make specific recommendations to joint WGs and liaise to connect the two areas, additive and subtractive.

History and genesis of the project, with a focus on how standards / standardisation needs were identified and conceptually tackled

The driving force for this extremely demanding and ambitious project came mainly from the end users, who needed a machine capable of producing parts and according to their specifications. To deliver this objective, a well-balanced expert team was brought together. The 10 partners comprised six companies, two universities and two research institutes. Two of the companies were SMEs and there were three end users from the renewable energy, construction and aerospace sectors. The consortium also featured the whole of the supply chain needed to produce such a machine.

From the proposal phase there was always a clear idea of contributing to the development of AM-related standards. While there was no standards body directly involved, the project partner European Welding Federation is a liaison organisation to several CEN and ISO TCs.

At the beginning of the project (by the sixth month), a ‘Report on standardisation and pre-normative research (D6.2)’ gathering information on the existing AM standards was produced. Standards were identified, for each WP, to ensure that the project results were in line with existing standards. This document was the baseline for understanding what gaps existed at the time that needed to be covered by standardisation activities throughout the project.

Lasimm partners ensured that the project developments, from the 6th to the 36th month, were suggested and then integrated into new standards or standards under development. This alignment was done through the following standardisation bodies: ISO, CEN, ASTM International, American Welding Society and the British Standards Institution. There was a significant focus on ISO and ASTM International, since these were the standardisation bodies identified as most relevant by the industrial users.

The engagement with standardisation bodies started in the second month with participation in an AM workshop organised by CEN. The outcomes of this workshop were used to provide information about the standardisation status of AM and develop Deliverable 6.2 (D6.2) – Report on standardisation and pre-normative research. By the sixth month the first contacts with ISO, CEN, Portuguese Institute for Quality, Nadcap, AWS and ASTM International were made, allowing for further collaboration in their own activities. At the 12th month EWF was integrated as a member of D20 Committee on AM for AWS and in the Nadcap group for AM, followed by becoming a liaison member of ISO/TC 261 and CEN/TC 438.

From the 18th month onwards, Lasimm was represented (by EWF) in five ISO meetings (in the 24th, 25th, 32nd, 33rd and 36th months). From the 25th month, it was allowed to vote at ISO and CEN.

Finally, a new ISO joint group was created with the aim of developing standards to qualify personnel involved in DED-Arc, considering several materials and types of equipment used by industry. Besides the creation of this group, several standards under development were analysed to provide Lasimm inputs and feedback.

Standardisation activities developed during project implementation

Through its WPs the project contributed directly to the further development of 12 existing ISO/TC 261 (AM) standards. The most notable of these were linked to D6.6:

- ISO/ASTM PWI 52926-1 Additive manufacturing – Qualification principles – Part 1: Qualification of machine operators for metallic parts production preliminary stage (00) (ISO/PWI stage),

- ISO/ASTM PWI 52926-5 Additive manufacturing – Qualification principles – Part 5: Qualification of machine operators for metallic parts production for DED-Arc preliminary stage (00) (ISO/PWI stage).

With regard to HM, the project contributed to the development of standards though technical reports and recommendations, the most notable being a recommendation to create a new liaison between ISO/TC 261 and ISO/TC 39 – Machine tools. This recommendation was made at an ISO/TC 261 plenary meeting in September 2019. ISO will assess the need and the resources available to develop standards in this area.

Finally, a new ISO joint group was created with the aim of developing standards to qualify personnel involved in DED-Arc considering several materials and types of equipment used by industry.

Project results, outcomes and impacts

Results, outcomes and impacts achieved so far

Overall, the Lasimm project achieved its technical objectives of reducing costs and improving efficiency and production flexibility, including a 20 % reduction in time and cost, as well as a 15 % increase in productivity for high-volume AM production. However, it should be noted that the absolute values achieved depend heavily on the part being manufactured. The project results also led to the creation of two spin-off companies focused on exploring the project results in different markets (WAAM3D and FAN3D).

The main standardisation results of Lasimm – outlined above – resulted either in the establishment of new joint CEN/ISO WGs or in preliminary work items, leading to the development of new standards. Some of these results were achieved during the project duration and some others were and will be recommended to different standardisation bodies as future work.

In addition, in the last (36th) month of Lasimm a report detailing conclusions and inputs of this project related to standards in development and possible new standards to be developed ('Standardisation recommendation document' (WP6, D6.6)) was presented in the WG and JG relevant to Lasimm. This is not a public document but will also be shared within ISO/TC 261

Envisaged future results, outcomes and impacts

The pathway to new standards in AM, HM and their interface has only just begun, and partners are continuing to follow up the work done in Lasimm using their own resources.

Lessons learned – success factors, challenges and elements of good practice

Overall, the project has contributed strongly to the development of standards, and the partners are continuing to do this, based on the know-how gathered during the project. On this point, is important to note that it would be unusual for a 3-year R & D project to end in an adopted standard. While it is possible to contribute to standards the timescales for approval and adoption are simply too long for a 3- or even 5-year R & D activity.

It is not necessary for a project to have a standards body as a partner – in fact, they may not be suitable for this role – but it is critical to have partners who understand the standards process and who are engaged with standardisation bodies and the relevant ecosystem or can engage with them. At the beginning of Lasimm, there were only few standards, or internal ISO projects for their development, in AM. Specifically, at the time nothing existed for DED-Arc (wire + arc AM). Since then, industry has shown a high level of demand to fill standardisation gaps related to this process, and the Lasimm project was able to help. Partners participated in this engagement and provided their knowledge and expertise to the development of standards.

Furthermore, with the results of the project it was possible to complete some actions such as the creation of new work items and projects, recommendations for standards under development, creation of ISO/TC 261 JG74 and engagement with other standardisation bodies. As a specific example, during the Lasimm project, partners engaged closely with ISO to be a part of the development of ISO/ASTM 52902 – Additive manufacturing – Test artefacts – Geometric capability assessment of additive manufacturing systems. During the Lasimm project, it was possible to provide inputs of test pieces for DED-Arc from the WP dealing with machine design, development and testing. Input from the project partners contributed to these standards with essential content for industry. In addition, machine testing was carried out in accordance with the test artefact present in this standard. This illustrates the beneficial two-way collaboration Lasimm had with ISO. Comments and discussions on this development did not come only through the ballot process; the most important ideas were discussed in ISO/TC 261 meetings, when several experts gave their inputs.

A very valuable starting point for any R & D project is mapping existing standards and ensuring that project outputs can comply with them, while also identifying gaps where a new standard or liaison committee needs to be developed. Recommendations may be some of the most valuable outputs of R & D projects. However, workshop recommendations by

themselves are often not taken up strongly by industry, so they need to be aimed at the right groups and correct level (TC and liaison).

Technology areas that are at an early stage of development will have fewer existing standards, and both industry and standards bodies are very open to projects. Very established technologies, such welding, will have much more inertia to change. This needs to be considered when planning standards activities in an R & D project. In contrast, the status of standardisation, before and after the Lasimm project, witnessed a huge development. It passed from simply some ideas of what to do to now having around 20 public standards and around 34 under development. Standardisation in this field is now developing very fast to comply with industry demands, and Lasimm had a strong role in this process. The results of the engagement with this kind of projects are in sight, and further progress will come sustained by technical research in projects like Lasimm.

Case study 2: Project no 958371 Ontology-driven data documentation for industry commons (OntoCommons)

CORDIS: https://cordis.europa.eu/project/id/958371

Project website: https://www.ontocommons.eu/

Start date: 1 November 2020

Duration: 36 months

Technology field: materials and manufacturing

Horizon programme line: CSA: H2020-EU.2.1.3. – Industrial leadership – Leadership in enabling and industrial technologies – Advanced materials; H2020-EU.2.1.2. – Industrial leadership – Leadership in enabling and industrial technologies – Nanotechnologies

Keywords: materials and manufacturing; data documentation; ontology commons

Project and standardisation element in brief ('abstract')

The OntoCommons project is a community support action dedicated to the standardisation of data documentation across all domains related to materials and manufacturing. The project aims to lay the foundations for standardising the format of data and ensuring interoperability so that it will be easier to use and distribute data in the two sectors of materials and manufacturing. The main aims of the project are to (a) develop a ready-to-use ontology commons ecosystem for data documentation, including a set of ontologies and tools; (b) cooperate and engage with relevant stakeholders at both EU and international levels to collect existing resources and tools for data storage and identify possible bottlenecks; (c) deliver a set of demonstration cases built upon the ecosystem that will prove the effectiveness of the approach through activities of harmonisation, standardisation and coordination; (d) develop and roll out an OntoCommons roadmap that will include a number of recommendations for policy instruments towards data sharing for the European single market. The work around standards supports the implementation of interoperability and findability, accessibility, interoperability and reusability (FAIR) principles, for the OntoCommons demonstrators in the nanotechnologies, advanced materials, biotechnology, and advanced manufacturing and processing application domains.

What the project is about

OntoCommons lays the foundation for interoperable, harmonised and standardised data documentation through ontologies, facilitating data sharing and pushing data-driven innovation, designed to bring out a truly digital single market and new business models for European industry, exploit the opportunities of digitalisation and address sustainability challenges.

Over its 36-month duration, the project is bringing together and coordinating data documentation and standardisation activities from the most relevant EU and international stakeholders and initiatives. The coordination activity is intended to result in the orchestration of an ontology commons ecosystem, composed of existing tools and specifications to achieve FAIR data documentation. The effectiveness of the ecosystem is being tested through a set of 11 industry-led demonstration cases, covering eight application domains. In order to build impactful demonstrators, OntoCommons has built a strong community of subject experts,

ontologists, implementers, industrial stakeholders and end users. Building a community of experts is essential to the final success of the project, which will rely strongly on the feedback of both stakeholders and demonstrators.

History and genesis of the project, with a focus on how standards / standardisation needs were identified and conceptually tackled

The OntoCommons idea has its genesis in the Industrial Ontologies Foundry, established in 2016, inspired by the Open Biological and Biomedical Ontologies Foundry and motivated by the growing number of ontology research projects in the engineering domains being developed without coordination or collaboration. While biomedical adoption of ontologies is successful, being very widespread, this is still not the case for the manufacturing industry. The Industrial Ontologies Foundry set out to address the risk that the ontologies resulting from engineering domains efforts would not be interoperable or scalable, particularly in Europe. The researchers behind the idea also recognised that, while there is significant traction taking place in this area in the United States through the National Institute of Standards and Technology, there was no clear counterpart action in Europe. Through a meeting held by the European Materials Modelling Council, an opportunity was seen to bring materials and manufacturing together and to have cross-domain interoperability and common standards that could be adopted by industry. The European Commission responded to this idea through a call.

Standards are a central part of the project, with industry-led demonstrators seen as critical to their development. By proposing a demonstrator, industry is given a concrete method to articulate its needs and the associated standards for the domain, or the need for a new standard then emerges.

Standards developed during project implementation

At the 12-month mark, the project was focused on the demonstrators, and their associated standards had been identified. These will be the platform from which new standards may emerge.

Project results, outcomes and impacts

As of November 2021, 11 industry demonstrators were under construction. The project is targeting a total of 20 industry led demonstrators before its completion. The project has also forged links to other relevant actions including ‘Supporting European experts presence in international standardisation activities in ICT’ (StandICT.eu), an EU-funded CSA action. The development of the ecosystem and the OntoCommons roadmaps are still a work in progress. The final impact of this project will depend strongly on adoption by end users, and in particular industry. However, most ontologies are not standards, and achieving a standard is critical for adoption by industry. Transforming an ontology into a standard is a possible way forward; for example, ISO 15926 specifies an ontology for asset planning for process plants, including oil and gas production facilities. The project team is very active in communities exploring this approach.

Lessons learned – success factors, challenges and elements of good practice

For ontology to achieve its full potential, there is a need for better cooperation between disciplines. This field is currently being led by the semantic web community (i.e. computer scientists). However, they focus on the formats of the ontologies and the capacities to process them, more than on their content in terms of semantics and domain coverage. There is a need to develop bridges between ontologists, implementers and domain experts. This

requires translation activities that are planned in OntoCommons. Manufacturing and materials are connected, but there is currently also a disconnect between the two sectors than could be bridged through adopted ontologies. However, most ontologies are still not FAIR: they can be found but they are not interoperable, and they are not well documented. There are also few integrated tools for their development, e.g. user-friendly interfaces. Alongside the challenge of getting industry to adopt ontologies that are not yet standards, there is also the issue of data confidentiality. It is not easy to persuade industry to share data, but it is easiest to persuade it to share the data models through ontologies. ‘Share and gain’ is the concept promoted, but it is not an easy one to get industry to accept. Digitisation has created many data ‘locks’ and an ongoing issue.

Case study 3: Project no 721045 Nextower

CORDIS: https://cordis.europa.eu/project/id/721045

Project website: https://www.h2020-nextower.eu/

Start date: 1 January 2017

Duration: 30 June 2021

Technology field: energy (solar)

Horizon programme line: innovation action (IA): H2020-EU.2.1.3. – Industrial leadership – Leadership in enabling and industrial technologies – Advanced materials; H2020-EU.2.1.2. – Industrial leadership – Leadership in enabling and industrial technologies – Nanotechnologies

Keywords: advanced ceramics; solar receivers; ISO standards; CEN-CENELEC

Project and standardisation element in brief ('abstract')

Tower solar systems are appealing for their great environmental compatibility. They also offer tremendous potential for efficient (electrical and thermal) power generation. Their industrial exploitation has so far been hindered by limitations in the materials used both for the central receiver – the core component – and for thermal storage. Nextower set out to develop a set of innovative high-performance ceramic and metallic materials to boost the performance of atmospheric air-based concentrated solar power (CSP) systems to make them commercially viable.

Over the course of the project, Nextower contributed a CWA proposal to set the stage for an upcoming ISO standard for these types of high-tech components (CWA 17726 'High temperature accelerated ageing of advanced ceramic specimens for solar receivers and other applications under concentrated solar radiation'). The project also drafted an amendment to the current standard on thermal diffusivity determination with the laser / light flash method (ISO 18755:2005), submitted it to ISO, and started a new process for extending this standard at European level and having it endorsed by CEN-CENELEC. Both aspects of standardisation are seen as important in ensuring that the product enters the market, and in bringing both societal and environmental benefits.

What the project is about

Nextower aimed to introduce a set of highly innovative ceramic and metallic materials to boost the performance of atmospheric air-based CSP systems to make them commercially viable. One of the technical aims of the Nextower projects was to develop bulk materials and joining materials for durability at the component level, to achieve 25 years of continuous maintenance-free service of the receiver and maximum thermodynamic efficiency at system level. The successful achievement of a new generation of materials allowing for virtually maintenance-free operations of the ceramic parts and increased working temperatures will drive the next generation of air-coolant CSP, highly competitive against other CSP alternatives and sustainable power supply options.

History and genesis of the project, with a focus on how standards / standardisation needs were identified and conceptually tackled

Standards were seen as a key advantage in bringing the technology to market by ensuing early acceptance from the industrial community in this highly regulated sector, and the project partners insisted on having the Spanish Association for Standardisation (UNE) and the Building Materials Testing Laboratory Certimac as full partners rather than as subcontractors. Their role was to systematically review all the results that the researchers were producing. This ensured that results would be ready to reach the industrial community, backed by standards, as fast as possible. It was seen that this would grant an advantage to the European ceramics industry but also create benefits for society and the environment from rapid updating of the technology.

Standards developed during the project implementation

Over the course of the project, Nextower created a CWA proposal for setting up a stage for an upcoming ISO standard for these types of high-tech components (CWA 17726 'High temperature accelerated ageing of advanced ceramic specimens for solar receivers and other applications under concentrated solar radiation'). The project also drafted an amendment to the current standard on thermal diffusivity determination with the laser / light flash method (ISO 18755:2005), submitted it to ISO, and started a new process for extending this ISO at European level and having it endorsed by CEN-CENELEC. Both aspects of standardisation are seen as important in ensuring that the product enters the market, and in bringing both societal and environmental benefits. The CWA and amendment were endorsed by all project partners and are now being vigorously disseminated to the wider community. This will help with final approval and adoption.

Project results, outcomes and impacts

As a result of the project, the companies involved now have two ceramic products to place on the market that have been tested using methodologies to be ratified in the upcoming standards. The wide dissemination of the proposed CWA and amendment is seen as supporting their rapid uptake, and the trajectory for technology adoption will benefit, with associated economic impact for the partners. Other ceramic producers will also ultimately benefit from being able to use the adopted standard in their own work. It is expected that the novel metals will follow a similar route, with similar benefits, but at a slightly later stage. The work on metals has proved more challenging.

Lessons learned – success factors, challenges and elements of good practice

Early collaboration between the standards community and the research community is ultimately beneficial for society and the environment, and both sides enjoy this type of collaboration. By partnering, standards agencies receive the direct benefit of access to resources, including expertise and knowledge. Researchers are exposed to the methodology and language of standardisation, and this is important from TRL4 onwards and critical for TRL6 and above. The interface ensures benefits for the commercial sector as well as for society and the environment. Adoption of standards across Europe is a lengthy matter involving many individuals and voting rights in each Member State. An EU project is a perfect springboard for setting in motion the machinery and mechanism for adoption, as the different partners can raise awareness and build support in their Member States. Where national standards agencies or committees lack technical expertise in a particular field, then researchers from the project can even be invited to sit as technical experts at the technical table and represent the committee. This can provide extra exposure for the committee. EU projects themselves should be regarded as organisations, and a standards task force needs to be created in the same way as a corresponding function would exist in a company.

Because it is rarely clear at the beginning what will be created by way of standards, the most critical task is to create the right team for the standards function. This needs to include strong management, as skills standards approval is a management task (not a technical one). The standards team must be part of the senior decision-making team and not regarded as cosmetic or token.

Case study 4: Project no 723441 Innovative multifunctional vacuum insulation panels for use in the building sector (InnoVIP)

CORDIS: https://cordis.europa.eu/project/id/723441

Start date: 1 October

Duration: 31 July 2020

Technology field: highly efficient insulation materials with improved properties

Horizon programme line: IA: H2020-EU.2.1.5.2. – Technologies enabling energy-efficient systems and energy-efficient buildings with a low environmental impact; H2020-EU.2.1.3. – Industrial leadership – Leadership in enabling and industrial technologies – Advanced materials

Keywords: vacuum-insulation-panels; VIP; super-insulation; nano-materials; thermal performance

Project and standardisation element in brief ('abstract')

The InnoVIP project was aimed at developing improved vacuum insulation panels (VIPs) made of insulating material, to be used in the opaque parts of the building envelope – in both newly built and existing houses – to improve the thermal performance and energy efficiency of the building. The VIPs developed were intended to exhibit improved thermal performance over their lifetime and be adjustable, mountable and machinable. In addition, the project set a goal of reducing the embodied energy by weight reduction and the use of an alternative core material, and lowering the cost of the final product by 20 %. Such a result would lead to a breakthrough in the energy efficiency of the opaque parts of the building envelope, in both newly built and existing houses, with the success of the development process to be validated by testing prototype VIPs in labs and two real-size demonstrators for roof and wall insulation in Poland and Portugal.

Over the course of the project the committee CEN/TC 88 WG 11 further developed the draft standard (Draft EN 17140 Thermal insulation products for buildings – Factory-made vacuum insulation panels (VIP) – Specification). This was used in the project to determine all mechanical properties of the new VIPs and their performance over time.

What the project is about

The building sector accounts for a large amount of the greenhouse gas emissions in Europe, and a dramatical reduction is unavoidable if the EU wants to meet its climate targets. This has led to ever-increasing regulation to support both climate protection and consumers, e.g. the energy performance of buildings directive, the energy efficiency and renewable energy directives, the Green Deal and European climate protection measures such as 'Fit for 55'.

Driven by this increasing regulation, there is a strong need to reduce energy consumption in buildings. This can be achieved by decarbonising heating, cooling and electricity, in combination with improving the thermal performance of the building envelopes, e.g. by improving the performance of insulating materials. The ultimate aim of the InnoVIP project was the development of highly efficient, multifunctional products at an affordable cost with outstanding thermal performance that is stable for at least 25 years. InnoVIP set out to develop the new product and demonstrate that, in principle, it is ready for use in several

applications including internal application underneath screed (floor), internal and external roof insulation, and internal and external wall insulation.

History and genesis of the project, with a focus on how standards / standardisation needs were identified and conceptually tackled

Harmonised European product standards for building materials allow producers to sell their products on a large common market, making use of harmonised procedures to determine and declare their performance. This enables users to select from a large variety of products from different manufacturers throughout Europe. Therefore, drafting a harmonised European product standard for VIPs was an attempt by different manufacturers to enlarge their market and overcome differences in national regulations in the different Member States. The standardisation work started in 2012, with the focus on VIPs, as they had been used in the building sector since 2000: multi-layered barrier laminates filled with a pre-compressed core of fumed-silica powder boards or glass fibre mats.

Responding to the regulations, and aware of the need to drive forward a standard, some members of WG 11 (FIW, LNE, Va-Q-tec and Avery Dennison Hanita) saw an opportunity in this H2020 call to refine the existing design of insulating material VIPs by improving the core material (lighter and better-performing loose fumed-silica powder), the laminates (cheaper and with a higher barrier for water vapour and air), the mounting and fixing (by embedding the new VIPs in components and systems), the handling and the durability. They later became the core group of the InnoVIP consortium. Simultaneously the project partners continued their work for WG 11 and saw an opportunity to push forward the associated draft product standard (Draft EN 17140), widen the scope of the standard to include InnoVIP-type products, and amend and adjust the test procedures in such a way that they can be applied to InnoVIP-type products as well.

The active involvement of several partners from the InnoVIP consortium in the product standardisation group for VIPs for buildings (CEN/TC 88 WG 11) ensured the instant transfer of the experiences from the project into the standardisation process. Conversely, they could validate the amended and adjusted procedures by applying them to the newly developed product.

In addition, the project team also liaised with several other standards committees, including CEN/TC 88 ‘Thermal insulating materials and products’ as the umbrella committee for harmonised insulation products in Europe, CEN/TC 350 ‘Sustainability of construction works’, and ISO/TC 163 ‘Thermal performance and use of energy in the built environment’ as the relevant ISO committee for mirroring the energy efficiency for buildings activities from CEN for worldwide application; for example, TC 163 SC 3 WG 11 is the ISO equivalent to CEN/TC 88 WG 11 for VIPs. This interaction was aided by existing contacts and established relationships; for example, Andreas Holm, the institute director of FIW, is also the chair of CEN/TC 88.

Standards developed during implementation of the project

The standardisation work for developing a harmonised product standard for VIPs for buildings started in 2012 (CEN/TC 88 WG 11), and a first draft version of the standard (Draft EN 17140 Thermal insulation products for buildings – Factory-made vacuum insulation panels (VIP) – Specification) was issued in 2017. Several members of the InnoVIP consortium had been members of the standardisation committee for a long time before the start of the InnoVIP project. This ensured, on one hand, open-minded development of the testing procedures and rules in the standardisation process and, on the other hand, quick validation of the new procedures and rules by applying them to the InnoVIP products under development.

Project results, outcomes and impacts

On the technical side, the project has significantly advanced a number of materials and associated deployment procedures that have uses in industry, beyond the original single product targeted for improvement. For example, it was shown that the production process for loose-fill VIPs could be improved, and the improved version is now used for VIPs for refrigerators and transport boxes (including for those used for transport of COVID-19 vaccines); and the new types of laminates are now available on the market and used for various applications, e.g. for encapsulating standard VIPs. Other developments include ultrasonic welding technology for the sealing of laminates for VIP insulation.

The materials and processes promise economic benefit for the industry sector and associated impact for the environment and society. New projects are also emerging, e.g. on the economic benefit of using VIPs as building insulation in different European climates. The draft building standard that has been under development since 2012 has also moved closer towards approval and adoption.

It is possible that further developments from the InnoVIP project will make their way into the building material market in the future, e.g. the implementation of additional functionalities such as antibacterial or fire-retardant coatings in building elements. Even the full InnoVIP product, comprising multiple technical components, may be realised later. This will require more investment in R & D for some of the materials. There would again be associated commercial benefits for the sector.

Lessons learned – success factors, challenges and elements of good practice

Standards take an extremely long time to be developed and accepted, and the process can be political rather than just technical, as countries and companies act to protect their own emerging products and specific markets. In addition, one should distinguish between standards for procedures, methods and management, testing and measurement standards, and (harmonised) product standards, which benefit differently from research projects and have great differences in the boundaries of the standardisation work and time needed for implementation.

Harmonised product standards

Official EU mandates (e.g. Mandate M/103 to CEN-CENELEC concerning the execution of standardisation work on construction products, dating from 1994) were established many years ago and new products do not always fit the original technical description of the properties and mandated characteristics. In this situation there is a need for a translation of properties, characteristics and new test methods into the original terms, so they comply with the original mandate. The translation document, ‘Answer to the mandate’, needs to be officially accepted by the European Commission in written form before the standard can be officially announced in the *Official Journal of the European Union*. At the moment, the potential non-compliance of the draft standards with Mandate M/103 is blocking several harmonised European standards for building materials and insulating materials from publication in the Official Journal. As a solution, a universal document is being drafted that will conform with legal requirements of the EU and could be used as a template for harmonised standards in the EU in the future. In addition, the mandate documents will be revised within the next few years. Based on the current situation, standardisation is not the accelerator for European innovations in the construction sector that it could be. In fact, the project partners feel that legal issues raised by the Commission are actively blocking the publication of harmonised product standards, which is hindering the building material industry and is a massive barrier to a common market for building products. It is also important to set

KPIs for the new products in such a way that they are flexible and specific to the application rather than aiming to fit old terms and requirements in antiquated mandates. Establishing a specific set of properties needed for a product and communicating it to TCs would help to shorten the time taken to get new standards adopted.

Testing standards

It is good practice to use existing standards as far as possible and, if testing standards need to be changed to function for a new material, then to ensure that the TCs are made aware of why existing testing standards are not appropriate and what changes are needed. This information should be communicated from the research groups within Horizon to the TC, e.g. by actively collaborating with the WGs as members or guests. It then can be considered in the next revision of the testing standards.

Case study 5: Project no 731205 Wide-scale demonstration of integrated solutions and business models for European smart grid (WiseGRID)

CORDIS: https://cordis.europa.eu/project/id/731205

Project website: https://www.wisegrid.eu/

Start date: 1 November 2016

End date: 30 April 2020

Technology field: energy

Horizon programme line: IA: H2020-EU.3.3.4 IA - A single, smart European electricity grid

Keywords: smart grid; renewable energy; consumer; prosumer energy community.

Project and standardisation element in brief ('abstract')

The WiseGRID project set out to develop a portfolio of smart, secure, stable and affordable solutions to address a need for better energy storage technologies, increased share in renewable energy storage and the integrating of charging infrastructure to favour the large-scale deployment of electric vehicles. It aimed to meet the needs of consumers, prosumers and industry through nine WiseGRID solutions, demonstrated and evaluated at pilots located at four cities in the EU. The focus of the project was on using existing standards for commercialisation purposes, but also to advance some work on standardisation.

During the project the consortium identified relevant standards and developed a CEN-CENELEC workshop agreement 'Reference model for distribution application for microgrids'. In addition, a data model using the IEC61850 communication protocol was implemented at a project energy local storage advanced system pilot site. Involvement of an SDO was a critical success factor for navigating existing standards and to position the project in relevant standardisation activities.

What the project is about

The WiseGRID project focused on the expected EU energy transition whereby consumers will increasingly be able to generate their own electricity from a variety of renewable sources. There is a need for solutions, technologies and business models that will increase the smartness, stability and security of an open, consumer-centric European energy grid and provide cleaner and more affordable energy for European citizens, through enhanced use of storage technologies and electro-mobility and a highly increased share of renewable energy resources. To help meet this need the WiseGRID project brought together 21 partners including electric cooperatives, distribution system operators, technological providers, energy providers, legal advisors and research institutes, from Belgium, France, Germany, Greece, Italy, Romania, Spain and the United Kingdom. It also included UNE as a consortium partner. The project focused on the development of better storage technologies, an increased share of renewable energy sources (RES) and the integration of charging infrastructure to favour large-scale deployment of electric vehicles.

The main outcome of the project was the development of the WiseGRID toolbox, a set of nine technologies that have been validated in real market conditions. These include the

WiseGRID InterOperable Platform, a secure and open ICT platform that utility companies can use to achieve real-time monitoring and decentralised control of the energy network. Researchers also developed WiseCORP, an application that lets businesses, industries, energy service companies, public facilities, consumers and prosumers become active – and smarter – energy players. Other solutions include an electric vehicle platform that car-sharing companies and charging point operators can use to optimise charging/discharging and reduce their energy bills, and the WiseHOME platform, which helps individual homeowners gain better control of their energy use.

These solutions were demonstrated and evaluated under real-life conditions in four large-scale demonstrators at four cities in Belgium, Greece, Italy and Spain to reflect different technological, climatic, regulatory, legislative and social conditions.

The project received three awards in 2018: Good Practice of the Year (Technology and Design category), EU Sustainable Energy Week Business Award and EU Sustainable Energy Week Citizens Award.

History and genesis of the project, with a focus on how standards / standardisation needs were identified and conceptually tackled

WiseGRID grew from the concept of local energy communities and had its roots in several earlier projects involving the partners, including NobelGrid (www.nobelgrid.eu). At project conception, the partners identified pilot sites to work on the idea of energy community and environment. The underlying concept was to place consumers and prosumers at the heart of smart city applications and tools that were applicable to energy communities.

The issue of standards was seen as critical from the beginning to ensure that the partners could rapidly place products on their existing markets and have them replicated for economic gain in other counties. To facilitate this, the consortium involved UNE as an organisation that could guide and steer it through the standards environment and associated processes. It was not the primary intention to develop new standards; this was not seen as needed, and it was clear that this would be a process extending beyond the lifetime of the project, which might slow return on investment for the partners. The main objective was to ensure that the technology would be fully compliant with existing standards.

Most of the WiseGRID partners were involved in the investigation of the standards and data models, more specifically UNE, as the partner with most expertise in standardisation, and the enterprise partners in charge of developing the WiseGRID products. WiseGRID consortium face-to-face meetings took place in Kythnos (June 2017), Crevillent (September 2017) and Athens (November 2017). They were vital to identify the interfaces and map the WiseGRID tools to an International Electrotechnical Commission (IEC) smart grids standards map. The output of these workshops formed the basis of the contents of a CEN-CENELEC workshop agreement.

Standardisation activities developed during project implementation

The main standardisation activities that took place over the course of the project were the following.

- An initial review of current standards resulted in D3.1 ‘Architecture, data models, standards and data protection (V1)’ (submitted in the 12th month).

- The resulting recommendation of an appropriate set of standards and new data models based on ontologies gave rise to in D3.2 ‘Architecture, data models, standards and data protection (V2)’. This output provides all the final information related to the architecture, standards, data models and data protection impact assessment of the WiseGRID project.

- A CEN-CENELEC workshop agreement ‘Reference model for distribution application for microgrids’ entered the public phase of commenting in June 2020.

- A data model using the IEC61850 communication protocol was implemented at a project energy local storage advanced system pilot site.

- A WiseGRID strategy for contributing to standards was defined, with a focus on Spain and Germany. In Spain, UNE will monitor the development of international standards, from the IEC or others, related to the integration of electrical energy storage systems in virtual power plants, and may promote the battery data model, because of the WiseGRID project, if the conditions to do so are met.

- In Germany, a WG has been established within the German Energy Storage Association. This WG is trying to introduce interoperable data models and communication protocols into the energy storage systems fabricated by its members and non-members. As of April 2020, the WG had internally agreed on a first version of a data model and was working on reference implementations of a representational state transfer application programming interface based upon that data model. The WG has not yet agreed to pursue standardisation of its data model at IEC or CENELEC level, but this is still being considered.

Project results, outcomes and impacts

The WiseGRID project aimed to successfully place on the market, by April 2022, a set of solutions and technologies that will increase the smartness, stability and security of an open, consumer-centric European energy grid, with enhanced use of storage technologies and a highly increased share of RES. This goal was met ahead of target. Products were ready for commercialisation and the consortium was involved in sales and marketing activities as of November 2021.

The consortium also set the goal of seeing significant impact in the business and innovation activities of the consortium, with a planned return on investment for the partners less than 30 months after commercialisation of WiseGRID products and services, contributing to the creation of jobs, access to new energy services for citizens and public/private organisations, saving in CO_2 and the increase of RES, among other impacts.

With products having been ready for commercialisation in late 2021, the consortium is hopeful of reaching this goal by mid 2023.

Lessons learned – success factors, challenges and elements of good practice

The development of the WiseGRID solutions and products has widely used the existing standards. Through this approach the results of the WiseGRID project have been moved closer to citizens in a reasonable time frame, the pilots can be replicated in new locations and the outcome has aligned with the interests of the commercial entities.

The design and implementation phases, including mapping of standards, were important in allowing the consortium to detect several topics capable of promoting contributions to standardisation, e.g. through workshop agreements. Using this mechanism, the project has also promoted adjustments needed to achieve the target of the project and satisfy the different realities of the pilot sites.

Having a standards agency as part of the consortium was enormously helpful. It was able to guide the other partners on existing standards and how to develop the CEN-CENELEC workshop agreement.

Case study 6: Project no 774500 Coordination of transmission and distribution data exchanges for renewables integration in the European marketplace through advanced, scalable and secure ICT systems and tools (TDX-Assist)

CORDIS: https://cordis.europa.eu/project/id/774500

Project website: http://www.tdx-assist.eu/

Start date: 1 October 2017

End date: 30 September 2020

Technology field: energy

Horizon programme line: IA: H2020-EU.3.3. – Societal challenges – Secure, clean and efficient energy; H2020-EU.3.3.4. – A single, smart European electricity grid

Keywords: TSO-DSO interoperability and coordination; scalability; security; interoperability.

Project and standardisation element in brief ('abstract')

This aim of this project was to design and develop novel ICT tools and techniques that facilitate scalable and secure information systems and data exchange to improve the performance of power systems. The particular focus was on horizontal exchanges between transmission system operators (TSOs) and vertical exchanges between distribution system operators (DSOs). The project developed three novel aspects of ICT tools and techniques: scalability, security and interoperability.

As a result of the project, two significant contributions were made to standards:

- fully defined interface specifications for TSO–DSO information exchange interfaces based on use case analysis and IEC 61970/61968/62325 standards to support highly automated information exchange and network analysis,
- fully defined interface specifications for information exchange between DSOs and market participants based on use case analysis and IEC 61850 and IEC 62325 standards to support highly automated information exchanges.

What the project is about

Information exchange between TSOs and DSOs has been identified as a key subject to improve the performance of power systems. One of the main challenges is the need for more interactions between actors not only horizontally, TSO–TSO, but also vertically, e.g. TSO–DSO, DSO–DSO and DSO–significant grid user. This is becoming increasingly important because most of the distributed RES and the significant grid users are now connected to distribution networks operated by the DSOs.

To help meet this challenge, the TDX-Assist project focused on TSO–DSO interoperability and aimed to facilitate scalable and secure information systems and data exchange between TSOs and DSOs. It did this by developing novel ICT tools and techniques for these purposes. The three novel aspects developed in the project were scalability – ability to deal with new

users and increasingly large volumes of information and data; security – protection against external threats and attacks; and interoperability – information exchange and communications based on existing and emerging international smart grid ICT standards.

History and genesis of the project, with a focus on how standards / standardisation needs were identified and conceptually tackled

The idea for the TDX-Assist project emerged from earlier projects led by the consortium partners and involving system power operators and DSOs, in which it had become apparent that standards were a missing aspect and that they held the potential to address issues such as scalability, security and interoperability. In particular, IEC-based standards could be used to formally define use cases for the industry.

The need for standards aligned well with the call from the European Commission. A partnership was brought together that included members who were part of relevant TCs so that relevant contributions to standardisation activities (suggestions for development of new standards and amendment of existing ones) could be easily submitted to the system.

Standardisation activities developed during project implementation

A number of activities took place that resulted in deliverables related to standards.

- The project commenced with a survey designed to confirm present standards (state of the art), provide feedback on the need for any standards development (gap analysis) and assess conformity with selected standards. It also considered aspects such as how often different parts of the relevant business ecosystem exchange data on a topic.

- Updates or 'extensions' to ICE proposals were then formulated and submitted to relevant TCs.

- Finally, standardisation feedback loops were established with IEC, CEN-CENELEC/ETSI standardisation bodies and WGs to facilitate TSO–DSO information exchanges.

Project results, outcomes and impacts

The following key TDX-Assist project objectives and outputs were achieved.

- A model-driven methodology to define and support TSO–DSO business and system use cases was developed. All interoperability layers of the smart grid architecture model were addressed, using IEC standards and associated tools.

- A repository including use cases, the Common Information Model and associated profiles was developed.

- Use cases relating to DSO to markets secondary ICT systems were developed. In addition to documenting the state of the art, services needed were defined and catalogued with their corresponding payloads.

- The overall TDX-Assist architecture was defined and documented.

- TSO–DSO information and data access portals were designed and developed based on scalable, secure ICT infrastructure that can also give access to a wider range of stakeholders as appropriate to enhanced TSO–DSO interaction.

- Use cases, processes, methods and techniques developed within the project were transformed into a series of evaluated TSO–DSO demonstrations, trials and field tests.

The TDX-Assist project addressed the further R & D needed to ensure that greater levels of TSO-DSO interoperability can be realised, and to harmonise a wider range of standardisation activities. This is an ongoing action for several of the project partners, and moving rapidly. It includes the adoption of standards by the European Network of Transmission System Operators for Electricity, and the setting up of testing labs.

Lessons learned – success factors, challenges and elements of good practice

Involving individuals who were part of the relevant TCs was very important for understanding the standards process and getting the suggestions for extending standards in front of the correct group. For TDX-Assist, this was strongly aided by having an industry advisory panel that was able to streamline the process. However, ultimately there is a limit to how fast a standards activity can be accelerated, because there is a formal process to be followed.

Extending rather than reinventing standards is important, and starting a project with a survey of the state of the art will facilitate this process.

Some countries, and by extension their industries, are not well represented in international TCs. This can curtail the competitiveness of the industry. Getting more individuals onto a TC requires employers to support their employees to take this step and to value it as part of professional development and for the benefit it will bring to the company and the industry.

Case study 7: Project no 723764 Agent oriented zero defect multi-stage manufacturing (GO0D MAN)

CORDIS: https://cordis.europa.eu/project/id/723764

Project website: https://go0dman-project.eu

Start date: 1 October 2016

End date: 30 September 2019

Technology field: multistage manufacturing

Horizon programme line: IA: H2020-EU.2.1.5.1. – Technologies for factories of the future

Keywords: multi-stage manufacturing; cyber-physical systems; zero-defect manufacturing (ZDM); inspection tools and methods; multi-agent system, industrial communications; interoperability

Project and standardisation element in brief ('abstract')

Multistage manufacturing, which is typical of and important for many industrial sectors including automotive, household appliance and semiconductor manufacturing, is inherently complex. Defects that emerge at later stages necessitate rework or rejection. There is therefore a demand for the development of zero-defect manufacturing (ZDM) strategies at system level.

The main aim of the GO0D MAN project was to integrate and combine process and quality control for multistage manufacturing production into a distributed system architecture, designed to support ZDM strategies. The project set out to ensure that project results would be fully aligned with and compliant with existing standards, or, where standards did not exist, that the project would contribute to filling the gap. The standards aspect was dealt with in a dedicated WP with a five-phase methodology with the goal of identifying gaps in existing standards and proposing actions to address them. The project contributed to the Institute of Electrical and Electronics Engineers (IEEE) P2660.1 WG regarding definition of the recommendation practices and to the IEEE P2805 standard.

What the project is about

GO0D MAN set out to realise and deploy a ZDM framework for multistage production lines applicable to a variety of manufacturing sectors. It built use cases that are representative of key European industrial sectors and have different types of multistage production systems: the first use case concerned highly automated serial mass production of automotive components, the second concerned batch production of high-precision mechanical components for automotive electro valves, and the third focused on professional customised products such as ovens for restaurants. The project set out to ensure that project results would be fully aligned with and compliant with existing standards, or, where standards did not exist, that the project would contribute to filling the gap.

History and genesis of the project, with a focus on how standards / standardisation needs were identified and conceptually tackled

The GO0D MAN project built on the results of previous successful EU R & D & I projects including GRACE (http://grace-rri.eu). Previous experience of the need for and potential benefits of standardisation in GRACE led to the creation of a separate standards WP in GO0D MAN with a very specific and systematic methodology to deal with the standardisation issue ([50]). The methodology consisted of five main steps: (a) identify standardisation objectives, (b) survey existing or anticipated standards, (c) align and map standards, (d) undertake gap analysis and (e) make recommendations. It was applied to each of the five main topics: smart inspection tools; multi-agent systems; communication; data model and rules definition; and knowledge representation and data analysis.

Standards developed during the project

The projects largely confirmed that, if intervention was made early in the R & D process, results could be made compliant with existing standards. However, some gaps in existing standards were identified and recommendations made. In particular, in the area of multi-agent substances, the project contributed to the IEEE P2660.1 WG regarding the recommendation practices for the interconnection between software agents and physical devices, and to the IEEE P2805 standard aimed at the establishment of standards regarding edge computing nodes. The GO0D MAN consortium is working closely with the P2660.1 WG in the definition of the recommendation practices.

Project results, outcomes and impacts

Successful completion of this project has provided a replicable system architecture for ZDM. The results will be broadly applicable in a variety of industries to improve the overall quality and productivity of production systems. Because the architecture is compliant with the existing standards for automation, the smart tools can be deployed immediately on commercial production lines.

As a result of the GO0D MAN project a start-up is being established to bring the technology to market. The alignment with existing standards is likely to accelerate the update of the products and the resulting growth and scalability of the company. In addition, increased awareness of the new technology by industry adopters has changed their thinking in this field, and this is resulting in processes being changed to adopt the results. Again, this adoption is likely to be faster and less risky because of the confirmed standards.

Lessons learned – success factors, challenges and elements of good practice

The success of the standards aspect of this project has in part been attributed to making it a task in its own right. However, the need to focus on standards emerged at an early stage, indicating that thinking about compliance needs to be introduced at quite an early stage of R & D. Thinking about the standards is also helpful for the R & D team and may be a new approach for it.

It is helpful to take a very systematic approach but also to be realistic and plan for a timeline that may exceed the lifetime of the R & D project. For example, from beginning to develop a

([50]) See D10.4 'Report on standardization, community building and innovation transfer activities', available on CORDIS.

standard until its adoption may take 5 years, and it will not be under the control of the R & D team.

If it is not feasible to have a standards agency as a full partner, e.g. because the number of partners in the project of a WP is already significant, then involving individual experts who are associated with standards agencies will be helpful in providing a direct and tangible link that will raise awareness and accelerate the adoption process.

Case study 8: Project no 820699 Fostering synthetic biology standardisation through international collaboration (BioRoboost)

CORDIS: https://cordis.europa.eu/project/id/820699

Project website: https://standardsinsynbio.eu/

Start date: 1 October 2018

End date: 30 September 2021

Technology field: synthetic biology

Horizon programme line: CSA: H2020-EU.2.1.4. – Industrial leadership – Leadership in enabling and industrial technologies – Biotechnology

Keywords: synthetic biology; biological circuits; microbial chassis; Synthetic Biology Open Language (SBOL); standards in biological systems; genetic engineering

Project and standardisation element in brief ('abstract')

Synthetic biology (SynBio) is an emergent, multidisciplinary engineering research field that aims at (re)designing biological circuits for applied purposes. Examples of SynBio include producing synthetic rubber from isoprene for tyres, developing renewable bio-based acrylic that can match existing petro-acrylic's performance and cost but with a 75 % reduction in greenhouse gas emissions, and converting agricultural waste material into useful new surfactants.

The field is evolving so fast that it still lacks a consensus definition. As in any other engineering field, it strongly relies on the use of well-defined, universal and robust standard components. However, in contrast to mechanical engineering, SynBio does not yet have established defined and adopted biological standards, and there are both historical and technical difficulties in reaching that goal.

The main goal of the BioRoboost project was to further develop standards in biology in a holistic, systematic way, from the biological part to the experimental procedure in a given environment. The project approached this goal through international collaboration, encompassing the EU, the United States and representatives from Asia, with the aim of generating the most comprehensive collection of up-to-date information available on standards in the biological and non-biological realms. Project outputs include the white paper *Standardization in Synthetic Biology*, a set of specialised chassis for specific applications and the 'BioRoboost educational kit' ([51]). The result was a strong emerging consensus on standards in the biological and non-biological realms from diverse stakeholders including research, industry and representatives of peer-reviewed journals – the final group being key stakeholders in driving this field of standards forwards.

([51]) In synthetic biology, a chassis means an organism that houses and supports genetic components by providing the resources that allow them to function.

What the project is about

The field of SynBio has enjoyed significant success in recent years. However, like any other engineering field, it strongly relies on the use of well-defined, universal and robust standard components, and defining biological standards has presented major challenges of both technical and historical origins. The former include the interdisciplinary nature of SynBio, involving mainly biologists/biotechnologists and engineers, whose views on the standardisation of living beings tend to differ; among the latter are the intrinsic features of life (mutation, emergent properties, fitness biases, variability and, of course, evolution).

The BioRoboost project aimed to help overcome cultural issues and to dramatically advance progress in solving technical difficulties. It approached these goals in three ways: by gathering the most relevant stakeholders in all the aspects of standardisation in biology in Europe in a co-creation scenario; by empirically testing cultural (lab-centric) standardisation practices and promoting a consensus conceptual and technical redefinition of biological standards; and, finally, by fostering a realistic and flexible toolbox of standard biological parts, including a reduced set of specialised chassis for specific applications as well as a renewed conceptual framework to inform policymakers, scientists and other societal actors.

History and genesis of the project, with a focus on how standards / standardisation needs were identified and conceptually tackled

The BioRoboost project was the idea of a small group of Spanish researchers, which included highly reputed individuals in the field with an understanding of the need to extend the concept of standards in this field beyond research and into the education system. Their initial aim was to foster the topic beyond the current hype and to focus on agreeing what can be standardised in this discipline, e.g. metrology, genes, circuits, chassis and protocols. Because of the emergent and important nature of the field and the current lack of consensus on standards across the globe, the initiating partners saw the need to make the project fully international, and deliberately involved partners, individuals and stakeholders from beyond the EU. The result was a project encompassing 27 entities: 21 European and 6 non-European entities including top-level research laboratories, social scientists, companies and experts related to biotechnology from Europe, Asia and the United States.

The emergent nature of the field also led the project partners to focus on consensus building and help policymakers who are not from the field to translate emerging conclusions into policy actions (a white paper), awareness raising (a renewed conceptual framework) and educational aspects (resources for pre-HEI students) alongside the development of a flexible toolbox of standard biological parts.

The project had intended to organise a series of high-profile international events, including one in Singapore, to help them build consensus. This approach had to be modified due to travel restrictions imposed by COVID-19, and events were taken online, making them international, but without the clear intention of having them held beyond EU borders.

Involvement of stakeholders from the publication sector (journal editors) was a deliberate approach from the beginning; a consensus approach from influential journals to how this field should be reported was seen as an important step towards agreeing standards, even at the stage of a consensus on the terms that should be used when reporting research activity. In this respect, editors of journals create a positive feedback loop to foster the use of standards.

Finally, the project team saw the need to develop a set of specialised chassis for specific applications that could be utilised by research and industry to set the approach to standards on a clear road for the future.

Standardisation activities developed during project implementation

The project developed a number of standardisation activities through the WPs.

Under WP1 the consortium identified and defined the gaps and weaknesses of the standardisation process and proposed remediating strategies. This 'state of the art' task focused on reviewing the capability in common languages and tools, e.g. Synthetic Biology Open Language, and identifying opportunities where the development of new standards, descriptors and tools will facilitate development of the modelling field applied to SynBio.

Under WP2 the consortium established for the first time a small yet relatively comprehensive set of microbial chassis to be used in a much wider range of biotechnological systems.

Under WP3 the consortium recognised a need to extend existing bacterium standards into non-bacterial systems and identified standards for both yeast and mammalian systems.

Under WP4 the consortium employed social scientific research to further understand the place of standards, and standardised products and practices, in different social systems, including the study of gender, ownership and responsibility dynamics. This was approached by using ethnographic observations of participant's laboratories, and interviews with key figures in those labs. This WP also identified and brought together appropriate analytic tools from fields such as science and technology studies, which best served the effort to explore the varied communities working with the standards under study.

Under WP5 the consortium built on the conceptual work and mapping developed in WP4: it considered variability in SynBio's standardisation practices, to focus specifically on how standards may enable knowledge circulation and collaboration within and across SynBio communities and research groups. This WP focused on shareability and reusability as key social and ethical aspects of standards and standardisation. WP5 attended to the multiple communities and moral economies of SynBio (building on WP4), with a special focus on Synthetic Biology Open Language: the most comprehensive attempt at making SynBio shareable by standardising it.

Project results, outcomes and impacts

Beyond the direct outputs outlined above, the project participants perceived the main results as being consensus building in the wider stakeholder community and an associated shift towards development of standards. This has included statements from journal editors that will be included in journals about how to approach the topic in publications.

In the future, the project may result in the elevation of the Standard European Vector Architecture database to the level of a real standard through UNE.

Lessons learned – success factors, challenges and elements of good practice

Development of global standards requires the involvement of non-EU partners. This can be challenging for an EU project, in which funding, even to take part in a consensus-building activity, cannot easily be made available to some stakeholders. It is helpful to consider this at an early stage. In the long term, some reciprocity regarding funding, e.g. for US partners, would be highly beneficial.

For a field that is very wide, such as SynBio, it is very difficult to have a simple standard. It is helpful to ‘think small to go big’, e.g. to look for a specific tool and to build the tool library. A resource such as Standard European Vector Architecture (http://seva-plasmids.com/) is a good starting point.

Case study 9: Project no 875247 Battery design and manufacturing optimization through multiphysic modelling (Defacto)

CORDIS: https://cordis.europa.eu/project/id/875247

Project website: https://defacto-project.eu/

Start date: 1 January 2020

End date: 30 June 2023

Technology field: lithium-ion batteries

Horizon programme line: RIA: H2020-EU.3.4. – Societal challenges – Smart, green and integrated transport

Keywords: Li-ion cell materials & transport modelling; cells technologies

Project and standardisation element in brief ('abstract')

The Defacto project contributes to the development of next-generation lithium-ion batteries for the automotive market with a comprehensive open-source modelling tool. Using experimental data from two existing nickel–manganese–cobalt (NMC) cells to optimise algorithms, the platform developed in this project promises to reduce development time and cost while enhancing performance and durability.

As of November 2021, the project had produced an analysis of the applicable standardisation landscape and was planning possible contributions to ongoing and future standardisation developments including by disseminating information to standardisation TCs and by identifying a topic for a CWA.

What the project is about

Rechargeable lithium-ion batteries power everything from portable electronics to electric cars. Since the first one was launched nearly 30 years ago, they have continued to evolve to support rapid innovation of the products that depend on them. A critical bottleneck in today's lithium-ion batteries is the cathode material. Cathodes based on NMC are among the most promising for development. These materials could significantly reduce costs and enable longer driving ranges for tomorrow's electric vehicles. Defacto seeks to accelerate their development for the automotive market with a comprehensive open-source modelling tool. Using experimental data from two existing NMC cells to optimise algorithms, the platform developed in this project should reduce development time and cost while enhancing performance and durability.

The cell and battery industry uses standards that specify safety, performance and other requirements, used by suppliers and customers to specify their quality needs. In addition, these standards can also be used to meet regulatory requirements. Both of these requirements must be considered in a research project that is intended for a specific industrial market, because without taking these requirements into account it would be impossible to introduce the product onto the market.

The work is being based on an iterative exchange process for model development, validation and optimisation using two cell technologies for the automotive market: a commercial

NMC622/G cell taken from the product portfolio from one of the Defacto partners, and last-generation prototypes (NMC811/G-Si).

History and genesis of the project, with a focus on how standards / standardisation needs were identified and conceptually tackled

The project responded to a specific call from the European Commission in this field. As the sector has well-established standards and is regulated, it was clear that standards would need to play a strong role in the project, including addressing the issue of EU harmonisation. To ensure that it has the necessary competencies to address these issues, the consortium, which covers the whole cell-manufacturing value chain, also includes UNE.

Standardisation activities developed during project implementation

Defacto has taken a classical route to working with standards in an R & D project where existing standards already exist at global level. Specifically, it has commenced by identifying and analysing relevant standards that should be adopted by Defacto in order to introduce the product onto the market. In this case, there is a focus on high-power applications. The resulting report (D8.9 'Report on the standardisation landscape and applicable standards to be adopted by the DEFACTO project') lists relevant standards and will allow the project partners to understand the standardisation landscape, including the organisations involved (relevant TCs), and ensures that, where possible, existing standards can be used to perform the required characterisation and experimental tests needed for model development and validation. In addition, the alignment with standardisation work that is current and under development facilitates the compatibility of the proposed modelling tool with the current market practices and will help to accelerate cell development and the R & I process.

Over the duration of the project the partners are contacting relevant TCs to make them aware of the activities and to disseminate results – where possible through presentations. As the project partners are not members of the national committees, it is necessary for them to be invited to participate in these meetings.

The project also expects to contribute to new standards developments in specific topics related to the objectives of the project, including cell production and systematic measurements though a CWA. The approach to this task is still under development by means of a study and draft proposal to partners (as of November 2021).

Project results, outcomes and impacts

The main result so far is that, based on deliverable D8.9 'Report on the standardisation landscape and applicable standards', a test profile according to the standard IEC 62660 (Secondary lithium-ion cells for the propulsion of electric road vehicles) has been selected for characterising the cells. Since this standard is used in the industry to test cells, this will align the project results with the industrial requirements of the sector.

As a result of the study on the possible topics to be covered by the new standardisation documents, a proposal based on deliverable D2.1 'Report on the definition of parameters required for modelling and description of the validation protocol' will be presented to the consortium. This deliverable contains the parameters required for modelling and describes the associated validation protocols. The content of this deliverable is very useful for the cell and battery industry, and it can be enriched with input from other external parties. It may form the basis of a CWA.

The project is on course to achieve its objectives, and this should ultimately translate to both commercial products based on proprietary code and an open-source model.

Lessons learned – success factors, challenges and elements of good practice

The main success factor has been that, from the beginning, the consortium understood the importance of standards and has decided to use them for the development of the project. In this case, the adoption of the cell standard IEC 62660 was possible because it could be achieved with the means available in the project. However, adoption of a particular standard is not always possible in R & D projects because it requires very expensive equipment or laboratories that are outside the project budget. This might be a factor to be considered when putting the consortium together, but it would reply on a very good understanding of the standards needing to be adhered to. This is more normally a task for the early part of a project.

The main challenge has been the large number of confidential deliverables in the project. This greatly limits the options for topics on which to develop a standard, since by definition a standard is a public document. This should be considered when balancing development of new standards with confidential outputs.

The involvement of a standards body has been critical in gaining access to competencies in this field and better understanding the issue or regulations. NSBs will often see such involvement as aligning with their mission and understand that their presence on a consortium will lend weight to the project proposal.

Case study 10: Project no 644748 Think cloud services for government, business research (CloudWATCH and CloudWATCH2)

CORDIS: https://cordis.europa.eu/project/id/644748

Project website: https://www.cloudwatchhub.eu/

Start date: 1 September 2015

End date: 30 September 2017

Technology field: ICT

Horizon programme line: CSA: H2020-EU.2.1.1.3. – Future internet: Software, hardware, infrastructures, technologies and services

Keywords: cloud computing; cybersecurity; network security; small and medium-size enterprises

Project and standardisation element in brief ('abstract')

The CloudWATCH project aimed to accelerate the adoption of cloud computing across European private and public organisations. As a follow-up, the CloudWATCH2 project aimed to continue the cloud interoperability testing work started during the CloudWATCH project, while working to further support EU R & D on cloud computing, software and services across the full innovation life cycle and the move to market. Both CloudWATCH projects drove developments on common standards profiles with practical guidance on relevant standards and certification schemes for trusted cloud services across the EU.

What the project is about

CloudWATCH (2013–2015) and CloudWATCH2 (2015–2017) were SME-led coordination and support action projects that aimed to accelerate the adoption of cloud computing across European private and public organisations by offering independent, practical tips on why, when and how to move to the cloud, showcasing success stories that demonstrated the real-world benefits of cloud computing, and fostering interoperable services and solutions to broaden choice for consumers. Building on the outputs of CloudWATCH, CloudWATCH2 brought together highly specialised experts in standardisation, security, and related legal and pricing aspects, to help ensure that European R & I secured market uptake and sustainable competitiveness with new cloud services and products. This was done through cloud interoperability-testing events (i.e. cloud plugfests).

History and genesis of the project, with a focus on how standards / standardisation needs were identified and conceptually tackled

Both projects built on the challenges seen in the developing European cloud R & I space (missing standards, transparent pricing, better uptake of new services, etc.). CloudWATCH built on strong connections with the scientific and standardisation communities that were established in previous funded efforts with Siena1 and OGF-Europe 2. This included continued cooperation with standardisation and standard-developing bodies such as Open Grid Forum (OGF), the Storage Networking Industry Association (SNIA), the Distributed Management Task Force (DMTF), the International Telecommunication Union (ITU), ETSI and the Organization for the Advancement of Structured Information Standards (OASIS). The

main reasons for addressing standardisation were that it is a key requirement of the call for projects, and critical for conducting the research activities during projects (e.g. to agree on terminology or methodology).

Standards in standardisation during implementation

The project liaised with standardisation bodies at the start, and then chose to cooperate through engagement with the OGF and SNIA, and lastly through cloud interoperability plugfests (i.e. events where technology providers test each other's implementations of standardised specifications for conformance and interoperability in an arena where the test results are private, thus allowing for the testing of upcoming or pre-production products/services). The cloud standard guides and catalogues were dependent on the work of the SDOs (the DMTF, ETSI, OASIS, OGF, OW2 and SNIA). Standards were subsequently catered for in a dedicated WP and tasks on standards, specifications, risks and legal recommendations. The Cloud Interoperability Plugfest series expanded to include sponsorships and support at different events by several important standards organisations and software development projects, including the Cloud Standards Customer Council, CloudWATCH, DMTF, ETSI, OASIS, the OCEAN Project, OGF, OW2 and SNIA, and has been extended to provide access for cloud developers to a variety of support tools provided by these organisations.

Project results, outcomes and impacts

CloudWATCH created a portfolio of European and international use cases to identify common requirements from security and interoperability perspectives. These have been used to develop a set of common standards profiles around federated cloud services, which were rolled out within the framework of the EGI Federated Cloud and OGF Open Cloud Computing Interface. As one standard profile was deemed unrealistic and difficult to achieve given the developing landscape, a workable methodology for identifying cloud computing priorities was provided to enable the identification of suiting standards and a set of recommendations for how to create a company's own profile.

The CloudWATCH2 project aimed to continue the cloud interoperability-testing work started during the CloudWATCH project, which resulted in three cloud plugfests. The project impact lives on: firstly through the StandICT.eu rolling open call, which addresses the need for ICT standardisation, defining a streamlined process to reinforce EU expert presence in the international ICT standardisation scene; and secondly through CSA STARWatch, a software as a service application to help organisations manage compliance of their cloud services with CSA STAR requirements and best practices.

Envisaged future results, outcomes and impacts

The future development roadmap of the software intends to include a new feature to define the risk profile of the end user, which will leverage the work done in TC3.3 (D3.5 'Risk profile') and use it to define an appropriate set of structured questions to help organisations using STARWatch define a risk profile for their own needs, whether they are public authorities or small, medium-sized or large enterprises.

Lessons learned – success factors, challenges and elements of good practice

Overall, against the backdrop of the cloud scene being new at the time of the first project's start (and thus lacking developed standards), the projects did not want to favour any particular SDOs, to remain as objective and open as possible.

The challenges reported concerned the time it took for a TC to look at proposed materials, as well as a lot of bureaucracy that a 2-year project could not handle, considering the project and the ISO group's timeline.

Elements of good practice include:

- having both the expertise and the resources in place within the various standardisation bodies to contribute practically to the proposal for developments to a TC early on;
- considering the use of European Commission tools, such as StandICT.eu, which provides funding to contribute to standardisation activities;
- factoring in external time constraints on standardisation recommendations that a project might develop.

Case study 11: Project no 824292 Contributing to a well-reasoned set of airworthiness standards for mass-market drones (AW-Drones)

CORDIS: https://cordis.europa.eu/project/id/824292

Project website: https://www.aw-drones.eu/

Start date: 1 January 2019

End date: 31 December 2021

Technology field: ICT

Horizon programme line: H2020-EU.2.1.1. – Industrial leadership – Leadership in enabling and industrial technologies – ICT

Keywords: drones; civilian drones; EU regulation; safe drone usage

Project and standardisation element in brief ('abstract')

AW-Drones was a coordination and support action project that aimed to support the ongoing EU regulatory process for the definition of technical rules, standards and procedures for civilian drones to enable safe, environmentally sound and reliable operations in the EU. AW-Drones addressed more than 600 drone-related standards by collecting, categorising and assessing regulatory requirements. The project delivered a harmonised research methodology, recommendations and requirements for new or revised standards, a technical report, reference material and a web-based Drones Standards Information Portal.

What the project is about

AW-Drones was an SME-led, 36-month-long coordination and support action project, which ran from January 2019 until the end of 2021 and aimed to support the ongoing EU regulatory process for the definition of technical rules, standards and procedures for civilian drones to enable safe, environmentally sound and reliable operations in the EU. This objective was addressed by four main strands of activity:

- collection of information on ongoing and planned work on technical rules, procedures and standards developed for mass-market drones worldwide,
- critical assessment/benchmarking of all collected data to identify best practices, gaps and bottlenecks,
- proposition and validation of a well-reasoned set of technical standards for each category of drone operations,
- engagement with key stakeholders and end users (i.e. representatives of the whole drone value chain).

Ultimately, AW-Drones indicated which standards constitute acceptable means of compliance with one or more regulatory requirements.

History and genesis of the project, with a focus on how standards / standardisation needs were identified and conceptually tackled

The identified lack of harmonised standards was seen to be hindering the development of drone-related business at both global and European levels. A reliable regulatory and standardising framework had been identified by several studies and surveys (e.g. the European Drones Outlook Study, issued by Single European Sky ATM Research) as one of the main potential boosters for the drone business. To foster the growth of safe drone usage, therefore, there was a need to develop and implement coherent and interoperable global standards for drones in the EU. The American National Standards Institute roadmap and the European unmanned aircraft system standardisation rolling development plan served as starting points to understand the gaps and build the methodology to collect and assess existing standards. As well as being a requirement of the call for projects, the requirement for standardisation also came from the market and was strongly advocated for by the project's consortium of nine members.

Standards and standardisation during implementation

The project did not participate in ongoing standardisation activities, as its aim was to identify gaps in existing standards and provide this information to the SDOs. The project chose to cooperate with standardisation bodies in its field of interest by including SDOs, NSBs and TCs on the advisory board, and addressed standardisation activities as a cross-cutting issue in different WPs that were implemented throughout the project.

Project results, outcomes and impacts

The project delivered three reports and a web information portal containing the same information as the reports. The reports contained:

- a mapping of the regulation against the standards;
- identification of potential gaps;
- barriers to standards that can cover the whole regulation of drones.

Regarding the information portal, the Drones Standards Information Portal aims to display, in an easily accessible fashion, the technical standards already published or under development for the commercial use of drones worldwide, which the project collected and assessed against existing and foreseen regulations. Moreover, it contains information on standards' maturity levels, coverage of regulations and identified gaps. This web-based tool aims to facilitate risk assessment and mitigation implementation for drone operators.

The portal will be maintained for at least 3 years after the project's end in December 2021, with long-term plans to keep the information up to date. To this end, project leaders negotiated with relevant SDOs to guarantee the updating of the information.

The work done in AW-Drones was far from conclusive, and the project hoped to continue with the European Union Aviation Safety Agency and assess new standards, as well as potential gaps, citing notably the new revision of standards. This yielded the conclusion that several standards are still missing to define acceptable means of compliance with the agency's regulation on drones (e.g. some of the specific operations risk assessment requirements are not yet adequately covered by standards).

Lessons learned – success factors, challenges and elements of good practice

The project credits its success to having had good, close links with standardisation bodies, especially with TCs, as it maintained alignment between the findings of the project and existing standards, but also with the roadmap of standards under development. This was deemed helpful in re-steering the project and activities dealing with standardisation. It was deemed limiting to rely solely on official publications and websites, and not keep up with developments in the WGs.

Elements of good practice include:

- mentioning the findings of this alignment in the report;
- including a chapter on how the project has kept in mind the standardisation activities;
- inviting SDO representatives to public events of the project.

The challenges encountered included difficulties in accessing the full texts of the standards to be reviewed (more than 600 standards) due to budgetary constraints (most of them are released for a fee).

As a result, the project highlighted the need for better links between researchers and standardisation bodies to allow researchers more open access to standards.

Case study 12: Project no 653985 Adapting and maintaining the innovation management assessment tools and support enhancing the innovation management capacity of SMEs (IMP³rove for Future)

CORDIS: https://cordis.europa.eu/project/id/653985

Project website: https://www.imp3rove.de/

Start date: 1 October 2014

End date: 30 June 2019

Technology field: AM

Horizon programme line: CSA: H2020-EU.2.3. – Industrial leadership – Innovation in SMEs

Keywords: innovation management; SMEs

Project and standardisation element in brief ('abstract')

The H2020 project 'IMP³rove for Future' kicked off in October 2014 and ran until 2019, having originally started in 2006 and become a series of projects. It primarily aimed to adapt and maintain innovation management assessment tools, and to support and enhance the innovation management capacity of SMEs. It developed two standards, the ISO 56004 innovation management assessment and the ISO 56002 innovation management system, and involved a consortium of 10 members based in Germany.

What the project is about

IMP³rove stands for 'Improving innovation management performance with sustainable impact'. In 2014, the project 'IMP³rove for Future' was funded under H2020 to adapt and maintain innovation management assessment tools to support the development of services and enhance the innovation management capacities of SMEs. It delivered new online training and support services for intermediaries in innovation management, as well as the development and implementation of new online features for the IMP³rove platform.

History and genesis of the project, with a focus on how standards / standardisation needs were identified and conceptually tackled

The project first started in 2006 as an initiative of the European Commission's Directorate-General for Enterprise and Industry, and eventually became a series of projects. The first phase (lasting from 2006 until 2009) focused on developing a platform (digital business model) for better innovation management, and the second phase (2009 to 2010) was concerned with disseminating this platform. The project grew to become a H2020 project in 2014, structured in seven WPs. The project had been engaged in standardisation activities since 2008 at DIN and CEN levels (CWA 15899, 'Standardization of an innovation capability rating for SMEs', CEN/TC 389), and since 2012 also in ISO standards (TC 279). The expectations were that it would develop, and later on serve as convener to finalise, the standard CEN TS 16555-7, and to contribute to the succeeding standardisation activities in ISO/TC 279 as convener of the ISO/TC 279 (CEN 16555-7) WG 4 'Innovation management assessment' (ISO 56004) and member of WGs 1 and 2. Standardisation-wise, and from an EU project perspective, the project could have done without any standardisation, as it evolved

organically. Until 2019, the project covered all the aspects that were covered in standardisation documents on innovation management.

Standards and standardisation during implementation

The project management did not account for standardisation needs and activities during implementation (i.e. not in the sense of formally standardising them); however, there was very consistent (standardised) delivery of the training in Romania, but not under SEN or ISO standards.

Project results, outcomes and impacts

The project built the world's largest database on innovation management, comprising 10 000 companies in more than 90 countries, trained up to 2 000 professionals (500 professionals a year) in using the benchmarking tool and in providing business for SMEs, and established a network of trained business management advisers across Europe. The concept of innovation management has been integrated in the ISO 56004 innovation management assessment, while the ISO 56002 innovation management system, as an innovation strategy with guidelines and objectives, provides support for companies to realise their innovative visions, and to establish the processes needed to achieve their goals. The impact is thus threefold, considering the impact on Enterprise Europe Network staff members, SMEs and policymakers in Europe.

Lessons learned – success factors, challenges and elements of good practice

Elements of good practice include having a code of conduct and a clear agenda (given how frequently new members joined over the course of the project). This was crucial for making phasing them in and out easy and effective.

Success factors identified included the inclusive approach to project members (i.e. treating each project member as equal in discussions and having a multidisciplinary team).

Challenges related primarily to the length of the standardisation process and the quality of the chairperson of the TC (regarding political dynamics and how likely/able they were to integrate different opinions).

Recommendations included shortening the process for the first launch of the standard and updating the standard itself (particularly when it comes to developing standards for 'soft' topics, such as management standards (as opposed to tech standards), for which the standardisation process must be accelerated to avoid standards becoming outdated by the time they are published). Furthermore, some standards can and should be removed, as they no longer meet the requirements of today's technologies and the progress made to date. The relevance of standards may also be greater if the process is shorter in the light of the development dynamic in certain areas (e.g. sustainability).

In general, if the European Commission intends to include standardisation in research projects, standardisation processes must be adapted to the requirements of research projects and to the requirements of the researchers, so that engaging in standardisation activities pays off for them career-wise. The current standardisation process is not suitable for short- to medium-term projects but, if the CWA is better defined, then there may be an option for integrating standardisation in research projects.

In terms of best practices from a project perspective, be selective in nominating the chairperson and the project members, to ensure that a good mix of subject-matter experts,

companies/organisations and countries are represented, as well as prior experience in standardisation. The appointment of advisors in standardisation agencies (e.g. ‘standardisation alumni’) would be helpful to ensure that researchers have an accurate understanding and overview of what can, should and really needs to be standardised before embarking on a standardisation journey.

Case study 13: Project no 731778 High sensitivity, portable photonic device for pervasive water quality analysis (WaterSpy)

CORDIS: https://cordis.europa.eu/project/id/731778

Project website: https://waterspy.eu/

Start date: 1 November 2016

End date: 29 February 2020

Technology field: ICT

Horizon programme line: H2020-EU.2.1.1. – Industrial leadership – Leadership in enabling and industrial technologies – ICT

Keywords: water quality monitoring; portable high-performance device; photonics

Project and standardisation element in brief ('abstract')

The WaterSpy project addressed the challenge of providing quick and reliable water quality-monitoring data, which is critical for detecting environmental pollution and reacting in the best possible way to avoid human health hazards. It did so by developing water quality analysis photonics technology suitable for online field measurements, thus enabling fast, automatic sample analysis. The WaterSpy technology was integrated (for validation purposes) into a commercially successful water quality-monitoring platform, in the form of a portable device add-on. In terms of standardisation, the project aimed to understand both existing standards and those under development, and present the project's work in the field to be considered in water quality-related standards.

What the project is about

WaterSpy was an SME-led RIA project, which ran from 2016 until 2020, and addressed the challenge of water quality monitoring by developing water quality analysis photonics technology suitable for online field measurements. Quick and reliable water quality-monitoring data are critical for detecting environmental pollution and reacting in the best possible way to avoid human health hazards.

It can be difficult to gather such data, however, as water utilities rely heavily on frequent sampling and laboratory analysis to acquire this information. This is time-consuming and expensive, and usually does not provide the necessary immediate input to notify authorities. Compact, portable and high-performance devices for pervasive water quality monitoring are required to avoid this.

These devices should tackle limitations in detecting contaminants, bridging different technologies available and allowing online monitoring of possible contaminants. The WaterSpy technology fits this paradigm shift through its integration (for validation purposes) in a commercially successful water quality-monitoring platform in the form of a portable device add-on.

History and genesis of the project, with a focus on how standards / standardisation needs were identified and conceptually tackled

Standardisation was deemed to be critical for ensuring the success of the project's exploitation and/or market strategy. From the beginning, one of the consortium partners (Iren) monitored standardisation activities in the area, coupled with its daily experience of using water quality-monitoring technologies at work and following water quality standards. The aim was therefore to meet regulatory requirements, but in a vastly different way from what was already being done, by understanding what standards were under development in the area, and disseminating the project's work to be considered in water quality-related standards. Cooperation with standardisation bodies was done through relevant stakeholders (Water Europe, action groups of the European Innovation Partnership on Water, etc.) involved in the standardisation process.

Standards and standardisation during implementation

Standardisation activities were mainly implemented throughout the project, and were addressed in a dedicated task dealing with monitoring standards, standardisation requirements, compliance and interaction with WGs. At TC level, the project liaised with ISO/TC 147 and CEN/TC 230. The project did not deal with standardisation of the new method, as both the method and its associated technology were novel, so the project followed the exploratory aim of testing and validating it for potential further commercialisation and standardisation. Similarly, and for the same reasons, there were some low-level TRL discussions as the project progressed in its findings. Project management-wise, the project accounted for standardisation needs and activities, firstly by incorporating findings from the first draft on the state of the art in existing standards into its development requirements, and secondly by focusing on dissemination to organisations involved in standardisation (e.g. Water Europe) throughout the project's lifetime.

Project results, outcomes and impacts

WaterSpy developed cutting-edge photonic devices and techniques, coupled with new approaches to automated sample preparation and overall device automation, in order to provide new capabilities in water analysis.

The project delivered:

- quantum cascade laser light sources by Alpes Lasers;
- a balanced detection module by Vigo System;
- a (100) HgCdTe on (100) GaAs detector structure optimised at a wavelength of 8 µm;
- multiple innovations in the patent preparation stage or patent pending.

The main result of WaterSpy has been the development of a device that requires about 7 hours to detect the presence of as little as a single harmful bacterium in a 100-ml water sample, in line with European Commission and national regulations. In comparison, with currently used systems, the same analysis could take up to 3 days. The WaterSpy technology has been integrated (for validation purposes) into an existing water quality-monitoring platform in the form of a transportable device add-on. Additional results included some project

partners commercialising products (e.g. better simulation software development and an automated sampling incubator).

Envisaged future results, outcomes and impacts

Results that are yet to materialise include technical partners deciding on how to move forward with more extensive validation, which could continue paving the path further towards standardisation.

Lessons learned – success factors, challenges and elements of good practice

The project's success factors include the need for continuous monitoring by someone who really understands what is going on with standardisation activities, to get full value out of it. In the project's case, this proved a success, as Iren was very much involved in such activities and was able to influence the requirements. This not only helped the project design the approach, but also helped to disseminate results related to standardisation.

The main challenge identified was the COVID-19 pandemic, as the project was interrupted during the first months of 2020, when it was supposed to perform larger real-world validation. There was no chance of continuing this, which left the project needing more data from the field to drive standardisation activities.

Elements of good practice include understanding which standards apply to what the project is planning to do and proposing a course of work aligned with them, and having a plan for how the project is going to deal with standardisation activities during its lifetime.

Case study 14: Project no 815074 5G European validation platform for extensive trials (5G EVE)

CORDIS: https://cordis.europa.eu/project/id/815074

Project website: https://www.5g-eve.eu/

Start date: 1 July 2018

End date: 30 June 2021

Technology field: ICT

Horizon programme line: H2020-EU.2.1.1. – Industrial leadership – Leadership in enabling and industrial technologies – ICT

Keywords: 5G; end-to-end facilities; testing

Project and standardisation element in brief ('abstract')

5G EVE was an RIA project that ran from July 2018 to June 2021, and one of three fifth-generation mobile communication technology (5G) public–private partnership (PPP) infrastructure projects starting at that time. It defined itself as the European 5G validation platform for extensive trials, with the goal of implementing and testing advanced 5G infrastructures in Europe, specifically at existing sites in Greece, Spain, France and Italy, enabling a unique end-to-end 5G facility. In terms of standardisation, the project focused. on the one hand, on activities related to experimental procedures by contributing to methodologies and testing approaches and, on the other hand, on activities related to technology development, centred around the novelties developed as part of the development of the 5G EVE platform itself.

What the project is about

The 5G commercial network roll-out has been under way in Europe. This has prompted a need for vertical industry companies from different sectors to test their 5G-based applications in a 5G-enabled infrastructure flexible enough to reproduce different live network operation conditions, to ensure successful commercialisation.

5G EVE aimed to support the transition to end-to-end 5G networks in Europe by offering facilities to vertical industries and all 5G PPP phase 3 projects to validate their network KPIs and their services. The project's aim was to create the foundations for a pervasive roll-out of end-to-end 5G networks in Europe, with its technical objectives including:

- implementing Release 16-compatible (see https://www.3gpp.org/release-16) technologies at the four sites, starting by developing them from the current release, Release 15 (see https://www.3gpp.org/release-15);
- designing and implementing site interworking and multi-x slicing/orchestration mechanisms;
- implementing a vertical-oriented open framework;
- creating an advanced 5G-testing mechanism to validate advanced 5G challenges.

History and genesis of the project, with a focus on how standards / standardisation needs were identified and conceptually tackled

The 5G EVE project targeted vertical industries to experiment and pilot their business cases for being '5G-enabled' before moving to the commercial stage. A clear advantage for all the stakeholders in 5G business is the definition of a common, generic application testing and validation framework for 5G and beyond, which validates the vertical application or service in a systematic manner for different 5G technology choices and deployment environments. It is in this context that 5G EVE came together with a clear goal for standardisation, including the consideration of a specific project task for that purpose (resulting in the establishment of Task 6.2). This activity was perceived bidirectionally from the beginning (i.e. any progress in the standardisation field would affect the development of 5G EVE's experimental infrastructure, but also any progress beyond the state of the art derived from the project could be fed back to the relevant SDO). Standardisation needs were a prerequisite in the consortium's structure, as the project needed to successfully involve representatives of key vertical industries (Ericsson, Nokia, Telefonica, etc.) to allow for the testing of 5G applications and influencing of the design of end-to-end 5G services, and to provide an early assessment. No SDOs were involved in the consortium, although some consortium researchers participated in standardisation activities.

Standards and standardisation during implementation

The project focused its standardisation activities on the outcomes it deemed most impactful (firstly, activities related to the experimental procedures seen in contributions within methodologies and testing approaches; secondly, activities related to technology development based on new developments arising from the development of the 5G EVE platform itself). The project worked on two corresponding work items with the ETSI Core Network and Interoperability Testing TC (ETSI INT), which was also involved as a project advisory body.

From the start of Task 6.2, 5G EVE participated actively in the 5G PPP pre-standards WG, along with other WGs in the 5G PPP WG ecosystem, allowing the promotion and dissemination of the standardisation outcomes of the project, as well as exchanges about the project results with the rest of the 5G PPP community. Collaborating with other 5G PPP H2020 projects (5G-VINNI, 5Genesis, 5Growth) was strategically relevant, as it made it possible to strengthen the impact and widen the scope of particular standardisation contributions under a general statement and a common view of what needs to be standardised, despite the different methodologies used (as reported in WP2 deliverables).

Project results, outcomes and impacts

Results, outcomes and impacts achieved so far
5G EVE has contributed to the industry in two main areas, which follow its work items within ETSI INT:

- experimentally, by contributing to methodologies and testing approaches,
- technologically, by transferring to the industry innovations developed as part of the development of the 5G EVE platform itself.

With regard to standardisation activities, outcomes materialised in common terminology, recommendations and requirements for new or revised standards, as well as a technical report.

Envisaged future results, outcomes and impacts

Results yet to materialise are accounted for in D6.5 (https://doi.org/10.5281/zenodo.5070281), and the project is expected to be sustained through the two work items above, which ETSI INT will continue to develop.

Lessons learned – success factors, challenges and elements of good practice

Challenges encountered included clashing schedules among people involved (those working on the project and those working on standards), as it was difficult for people contributing to standards to also be adequately involved in the project, due to the timelines of the standardisation process. It is noted that the commitment of all the consortium's partners was key to ensuring a successful contribution to standardisation and contributing meaningfully beyond the state of the art.

An additional challenge was facilitating SMEs' contribution to standards development, due to both an initial lack of engagement from some of the project partners and the COVID-19 pandemic, which slowed down work'

With regard to recommendations, it was deemed crucial to have an overall understanding of what is being developed, so that projects can have a good overview of the state of the art, as well as clarity on what the standardisation bodies are developing, in order to know what to contribute to. Both were deemed essential for a clear view of what can and will be transferred to the industry. On the other hand, the project recommends creating a parallel calendar in the project proposal, to establish a clear roadmap of the contributions to be made to standards in parallel with the project's calendar of deliverables and contributions, helping the review process, but also clearly demonstrating the expected impact on the industry. It is noted, however, that this added calendar can be specified in a meaningful way only by projects that deal with more mature technologies.

Case study 15: Project no 873111 Digital platform for circular economy in cross-sectoral sustainable value networks (DigiPrime)

CORDIS: https://cordis.europa.eu/project/id/873111

Project website: https://www.digiprime.eu/

Start date: 1 January 2020

End date: 31 December 2023

Technology field: ICT

Horizon programme line: H2020-EU.2.1.1. – Industrial leadership – Leadership in enabling and industrial technologies – ICT

Keywords: circular economy; digital platform; smart factories; cross-sectoral value chains

Project and standardisation element in brief

DigiPrime is an ongoing IA project, which started in January 2020. The project is developing a digital platform for the circular economy to support the cross-sector circular manufacturing chain. The platform will strengthen recycling, remanufacturing and demanufacturing functions based on the exchange of digital data between participants in the circular economy, and could have a standardisation impact by providing reference implementations of novel concepts, such as product passports and data spaces, for the circular economy.

What the project is about

Digital technology will play a big role in our successful transition to a circular economy that makes optimal use of resources throughout industrial value chains. DigiPrime is an ongoing IA project that aims to develop a digital platform for the circular economy. The platform will help participants in the circular economy to exchange digital data, fostering the performance of functions in the circular economy, and enabling novel circular business models based on data-enhanced recovery and reuse of functions and materials from post-use products. Specifically, the DigiPrime platform will promote and demonstrate a federated model for the integration of digital platforms of different participants in the circular economy spanning different sectors. The platform is validated through several cross-sectoral pilots funded through an open call mechanism. They are further detailed in 20 use cases covering different European industrial sectors (automotive, renewable energy, electronics, textile, construction) and additional pilots in new sectors.

History and genesis of the project, with a focus on how standards / standardisation needs were identified and conceptually tackled

At present, product data and knowledge are not exchanged among value chain stakeholders or sectors, which blocks cross-sectoral circular economy opportunities. Moreover, there is poor uptake of products, including reusable materials, by end customers. DigiPrime addresses this problem by developing a digital platform concept, built to overcome current information asymmetry among value chain stakeholders. In order to unlock new circular business models, it identified data-enhanced recovery and reuse of functions and materials from high value added post-use products as the basis of its platform. Planned project standardisation activities covered two complementary aspects:

- taking advantage of existing standards (e.g. in relation to data modelling) to boost project implementation activities and avoid 'reinventing the wheel' as part of development activities,

- influencing future standardisation in the circular economy as a means to increase visibility and maximise the overall impact of the project.

Standards and standardisation during implementation

The project has a dedicated task related to standardisation. One of the project goals is to comply with existing standards as much as possible (e.g. in the development of the platform, as well as the sharing of data and information). Nevertheless, the project does not follow a specific standard or a strict standardisation direction. The project has liaised with organisations experienced in standardisation, but not SDOs. Specifically, the project channels its standardisation activities through industrial associations, such as the European Factories of the Future Research Association (EFFRA). Participation in the standard-related WGs of such associations is more flexible and easier than participation in SDOs, which have stricter rules and processes. The project became part of the Digital Manufacturing Projects cluster (under the EFFRA umbrella, https://www.effra.eu/), through which it participates in CEN-CENELEC standardisation workshops. Specifically, DigiPrime participates in a CWA workshop on ZDM terminology. The workshop's outcome is expected to affect the project only marginally, as ZDM is not relevant to the core aims of the project.

Other standardisation stakeholder interactions focus on the emerging concept of product passports. The project participated in the consultation of the European Battery Association and the European Commission regarding the European Digital Product Passport. Furthermore, the project provided guidelines for circular economy data spaces as part of a white paper for the Industrial Data Spaces Association and OPEN DEI project (Aligning Reference Architectures, Open Platforms and Large-Scale Pilots in Digitising European Industry).

Project results, outcomes and impacts

Currently, the project is halfway through building the digital platform. So far, a preliminary analysis of a subset of new business models enabled by the DigiPrime platform, within the pilots it plans to run, forecasts that the platform has the potential to achieve results equivalent to the following by 2025:

- a total increase in value added of EUR 425 million (economic);

- an estimated increase in employment of 10 000 jobs (social);

- a total saving in CO_2 emissions of 13 092 kilotonnes (environmental).

Regarding standardisation, expected outcomes with a standardisation impact involve inputs into reference implementation for product passports and data spaces for the circular economy (so far done as part of the consultation with the European Battery Association and as part of the Industrial Data Spaces Association and OPEN DEI project white paper, respectively). Additional expected impacts include those related to the digital platform's individual components that follow specific standards, as these will be good for data sustainability (e.g. for life cycle assessment or predictive asset management).

Lessons learned – success factors, challenges and elements of good practice

The project highlights its success factors so far as being tied to very tight and consistent project management (at central and individual levels), the decentralisation of tasks and the appointment of committed leaders. Elements of good practice regarding standardisation activities are the following.

- Including an SDO in the consortium or, if not, a partner with very good links to SDOs. This is especially important for successful standardisation work, as it enables the project to work on the target standards in a focused and effective way. It alleviates the need for lengthy explorative processes for understanding the relevant standardisation processes and establishing the required liaisons.

- Focusing on a limited number of standards (e.g. one or two). This is essential for being effective given the rather limited standardisation resources of the average EU-funded project. Focused work on specific standards must be pursued, rather than trying to engage with too many standards and SDOs.

- Ensuring a regular bilateral information flow between the project and the SDO, throughout the project's life cycle. This is important for addressing challenges associated with the lack of alignment of project timelines with the standardisation process.

Given the wealth of tech-related standards, projects could benefit greatly from services to help them identify the most appropriate SDO for their standardisation tasks. Such a service could help projects cope with standards fragmentation and avoid overlaps.

Case study 16: Project no 740129 The European watch on cybersecurity privacy (Cyberwatching.eu)

CORDIS: https://cordis.europa.eu/project/id/740129

Project website: https://cyberwatching.eu/

Start date: 1 May 2017

End date: 31 July 2021

Technology field: ICT

Horizon programme line: H2020-EU.3.7.6. – Ensure privacy and freedom, including in the internet and enhance the societal, legal and ethical understanding of all areas of security, risk and management; H2020-EU.3.7.4. – Improve cyber security; H2020-EU.3.7. – Secure societies – Protecting freedom and security of Europe and its citizens; H2020-EU.3.7.8. – Support the Union's external security policies including through conflict prevention and peace-building

Keywords: cybersecurity; privacy; digital single market

Project and standardisation element in brief ('abstract')

Cyberwatching.eu was a European observatory of research and innovation in the field of cybersecurity and privacy. The project aimed to contribute to making the digital single market a safer place by promoting uptake and understanding of cutting-edge cybersecurity and privacy services that emerge from R & I initiatives across Europe. Standardisation-wise, the project concerned itself with mapping standardisation and certification activities in EU organisations and projects, identifying standardisation and certification gaps, and issuing recommendations for future standards work programmes.

What the project is about

Cyberwatching.eu was an SME-led coordination and support action project lasting from 2017 to 2021. In its mission to democratise cybersecurity for all, the project aimed to directly respond to the objectives of the signed contractual PPP on cybersecurity (https://www.ecs-org.eu/cppp), which could become the reference framework for research and innovation initiatives across Europe.

The project engaged in:

- mapping of standardisation and certification activities in EU organisations (the European Union Agency for Cybersecurity, the European Cyber Security Organisation, etc.), and projects including competence centre projects;
- identification of standardisation and certification gaps;
- identification of requirements and realities for SMEs;
- recommendations on standardisation and certification priorities for future work programmes.

History and genesis of the project, with a focus on how standards / standardisation needs were identified and conceptually tackled

The project grew out of the identified need to make the digital single market a safer place by promoting the uptake and understanding of cybersecurity and privacy services that emerge from R & I initiatives across Europe. On the market side, given the risks that companies and organisations face ubiquitously with regard to cyberattacks, the project followed the EU Cybersecurity Act in aiming to establish an EU-wide harmonised framework to certify ICT products and services, and to raise awareness of how standards can help organisations act with confidence to protect themselves, and their customers and partners, from cyberattacks and data breaches. Standardisation was catered for in a WP dedicated to consultation, policy and standards, and in tasks focused on the path from research to standardisation and legal compliance in cybersecurity and privacy. On the policymaking side, it pursued the need to develop recommendations for and make sense of the landscape of European Commission-funded projects on the topic of cybersecurity, in terms of standardisation and what relevant gaps there are.

Standards and standardisation during implementation

The project management accounted for standardisation needs by understanding needs in the cybersecurity landscape, giving a recommendation on them, and assisting from a policymaking perspective. Interactions with standardisation stakeholders during implementation were done through participation in European Cyber Security Organisation WG1 meetings and contribution to their work, participation by WG members in the project's events, outreach at public webinars, the project's social media network and the process of collecting information from projects.

Project results, outcomes and impacts

The project delivered various deliverables within strategically identified fields, such as certification and privacy. Firstly, within certification, the Cybersecurity Label (see https://label.cyberwatching.eu/Pages/Home.aspx) served as a first step for SMEs in adopting cybersecurity certification. Secondly, within privacy, the GDPR Temperature Tool (see https://gdprtool.cyberwatching.eu/Pages/Home.aspx) was used as an important preliminary step for SMEs to facilitate their understanding of where they stand with respect to the general data protection regulation (GDPR) in terms of 'risk exposure to sanctions', while the Information Notices Tool (see https://www.cyberwatching.eu/cyberwatching-information-notice-tool) was created to help organisations have a more robust GDPR position by providing a practical checklist for the components required in an information notice.

The Cyberwatching Project Radar (see https://radar.cyberwatching.eu/radar) provides an interactive bird's-eye view of the complete collection of EU-funded projects in the cybersecurity space landscape by identifying which projects have standardisation as a topic, how much the European Commission has invested in standardisation and what gaps exist that policymakers can take into account. As the online hub for research and innovation in cybersecurity and privacy in Europe, the Cyberwatching.eu website offers European citizens a single gateway to innovative and trustworthy ICT products, services and software that take fundamental rights, such as privacy, into consideration. With regard to the sustainability of the project's results, the Cybersecurity Label, GDPR Temperature Tool and Information Notices are results being sustained by Trust-IT, ICTL and the Spanish Cybersecurity Innovation Cluster, and delivered to the Spanish Cybersecurity Innovation Hub, while it is hoped that the Radar will be integrated into the European Commission's Joint Research Centre (JRC) Publications Repository.

Lessons learned – success factors, challenges and elements of good practice

The project's success factors are tied to continuous engagement with SDOs and cybersecurity-landscaping activities, and an accurate understanding of SDO life cycles and TCs' timelines, to know how the project could effectively contribute to defining a standard.

The challenges included changes in the landscape that prompted a need for flexibility, as COVID-19 prompted a shift in the way budget was spent on events (virtual instead of physical). This eventually proved that dissemination activities such as webinars, instead of physical events, were actually more suitable to the project's objectives.

Good practices include forming a good understanding of the various priorities of the cybersecurity landscape and clearly communicating the financial benefits of standards for SMEs, as they are unlikely to be interested if there is not a clear takeaway for them, along with being able to see how it can differentiate a business from the competition.

Case study 17: Project no 773297 Monitoring the bioeconomy (BioMonitor)

CORDIS: https://cordis.europa.eu/project/id/773297

Project website: https://biomonitor.eu/

Start date: 1 June 2018

End date: 31 May 2022

Technology field: ICT

Horizon programme line: H2020-EU.3.2.4.3. – Supporting market development for bio-based products and processes; H2020-EU.3.2. – Societal challenges – Food security, sustainable agriculture and forestry, marine, maritime and inland water research, and the bioeconomy

Keywords: bioeconomy; bio-based products; bio-based industry; product passports

Project and standardisation element in brief

BioMonitor addresses the information gap in bioeconomy research by restructuring its existing data and modelling framework. The ultimate goal of the project is to get a clearer picture of how the bioeconomy affects our lives. This goal is achieved by establishing a statistics and modelling framework for the bioeconomy that is effective (supported by a stakeholders' platform) and robust (compatible with and implementable in existing systems of statistical and customs offices, laboratories and industries). Standardisation-wise, the project addresses the standardised classification and data collection systems to integrate new bio-based materials and products.

What the project is about

BioMonitor is an ongoing RIA-type project that started in June 2018 and addresses the information gap in bioeconomy research by restructuring its existing data and modelling framework. The overall objective of the BioMonitor project is to establish a statistics and modelling framework for the bioeconomy that is effective (supported by a stakeholders' platform) and robust (compatible with and implementable in existing systems of statistical and customs offices, laboratories and industries).

The project works through a threefold approach by:

- closing the data gaps observed when measuring the bioeconomy, by using new and improved datasets;
- enhancing existing modelling tools that guide industries and policymakers in defining long-term strategies;
- creating a stakeholder engagement platform and training modules to validate and disseminate the data and modelling framework developed by the project.

History and genesis of the project, with a focus on how standards / standardisation needs were identified and conceptually tackled

Over the last 20 years, EU policymakers have prioritised the expansion of bio-based value chains through various EU policy initiatives and research programmes. However, despite the growing popularity of the bioeconomy in Europe, information and statistics about it are lagging behind in various ways. These include lack of a comprehensive database and statistics for bio-based industries, lack of a transparent methodology for bio-based data collection, and lack of integrated value chain data and indicators that illustrate the flows of different bio-based materials' processing systems.

As a result, the BioMonitor project set out to address these gaps through the initial definition of products contributing to the bioeconomy's development (bio-based products), from which the project's standardisation needs arose. To identify those products, one has to standardise what they are composed of. The standardisation thus requires the knowledge of what the proportion of bioresources in a product is, and how it can be measured.

Standards and standardisation during implementation

The project liaised with SDOs such as the National Ecological Network and Environmental Assessment Agency of the Netherlands (project partners); other national organisations, from Ireland, Italy, Latvia and Slovakia; CEN; and Eurostat. These were chosen based on their expertise and relevance to developing standards at EU level.

The Dutch SDOs helped to organise and provide training sessions to which other national organisations were invited via the stakeholder platform where the methodologies and results of the BioMonitor project were shared. Liaison with current CEN standardisation work related to bio-based products will be established in 2022 to build on the existing standards for identifying and testing them, as there must already be a CEN standard in place for a bio-based product to be included in the statistics.

Project results, outcomes and impacts

The project is ongoing, and has so far developed the methodology for valuing the bioeconomy at both EU and national levels, and the contribution of the EU bioeconomy to reaching the objectives of the EU bioeconomy strategy. The project has delivered indicators at EU Member State level describing the development of the EU bioeconomy, made suggestions for expanding the database for bio-based products and the use of biological material, and developed an accounting system to incorporate bioeconomy considerations. The input–output-based models related to a standardised approach for all EU Member States are a result that would not have been possible without this first step towards standardisation. The modelling and projection part of the development of the bioeconomy is yet to materialise; in it, the JRC is expected to pick up the development of tools in its projection work. The project will be sustained beyond its lifetime through the JRC, which will continue collecting information to update the database.

Envisaged future results, outcomes and impacts are:

- the work of statistical and customs officers will be made easier;
- policymakers will be able to draft more effective bioeconomy strategies;
- bio-based industries will promote more evidence-based business planning through effective and transparent communication of bio-based items.

Lessons learned – success factors, challenges and elements of good practice

The project has faced several challenges. Firstly, the project team had to convince national statistical offices that data pertinent to bio-based products should be collected, and that there is a need to train country-level import organisations in handling such goods. Here, the acknowledgement of different country interests in the matter of bio-based products is necessary.

Secondly, the COVID-19 pandemic prevented the creation of a statistical database for bioeconomy products; this would require physical meetings in labs alongside staff training. The consequent moving online of these training sessions led to reportedly low levels of satisfaction on both sides.

Elements of good practice include getting SDOs involved from the start, keeping the communication flow regular and having at least one annual meeting with them besides attending events the project is invited to. The provision of space for SDOs in the project, so that they are not sidelined, is done through workshops. These workshops have to take place at regional level, as it is deemed unrealistic to expect all stakeholders to meet in Brussels.

Case study 18: Project no 687554 Second generation beacon for Galileo/EGNOS EGNSS search and rescue applications (Helios)

CORDIS: https://cordis.europa.eu/project/id/687554

Project website: https://helios-gsa-project.eu/

Start date: 1 March 2016

End date: 30 December 2020

Technology field: space

Horizon programme line: Industrial leadership – Leadership in enabling and industrial technologies

Keywords: search and rescue; satellite-based; distress beacons; antennas; emergency readiness and response

Project and standardisation element in brief ('abstract')

The Second generation beacon for Galileo / European Geostationary Navigation Overlay Service (EGNOS) and European Global Navigation Satellite System (EGNSS) search and rescue applications (Helios) project aimed to develop next-generation SAR distress beacons. The programme received nearly EUR 5 million (of which the EU's contribution was about EUR 3.5 million), which was used to design several innovative aviation and maritime SAR distress beacons in partnership with industry experts including Airbus, Air France, Sioen, Centre national d'études spatiales (CNES) and Cobham Aerospace Communications. Helios consortium members, such as Orolia, Cobham, CNES, Sioen, Air France and Airbus, were involved in different international standardisation WGs (e.g. Cospas-Sarsat, the International Civil Aviation Organization, the European Organisation for Civil Aviation Equipment (EUROCAE), the Radio Technical Commission for Maritime Services (RTCM), ARINC), ensuring that the development phase of the SGB and RLS was in line with the compatibility and interoperability required by Cospas-Sarsat.

What the project is about

The project aimed to provide a complete range of next-generation beacons to the market including an emergency locator transmitter (ELT), an emergency position-indicating radio beacon, a personal locator beacon and associated antennae, all compliant with the Cospas-Sarsat international standards. These new distress beacons are fully compatible with satellite-based SAR distress alert detection, the Medium Earth Orbiting SAR System and Galileo. As a global leader in SAR infrastructure and beacon manufacturing, Orolia, the project leader, was involved in specific WGs under organisations as the International Civil Aviation Organization, EUROCAE, the Radio Technical Commission for Aeronautics and the RTCM, and gathered the Helios members' expertise in aircraft manufacturing, airline modifications and protective clothing design, as well as SAR operations, with the final goal of saving more lives through innovative solutions in response to developing market problems.

The key objectives of the HELIOS project were:

- defining and developing products (beacons and associated antennae) compatible with EGNSS and SAR services and end users' latest requirements;

- Galileo EGNSS and SAR system validation;
- certifications for commercialisation.

Gathering the knowledge of major players recognised in their industry worldwide, the Helios project provided a vehicle for the European industry to lead the way towards safer, more innovative systems that respond to current and developing market problems.

History and genesis of the project, with a focus on how standards / standardisation needs were identified and conceptually tackled

The Helios beacons were conceived when the relevant standards (such as DO22A or ED62B) were not yet set firmly, and infrastructure was not yet ready. Therefore, the project had to follow, interact with and advise on the tuning of those standards. This necessity was reflected in Orolia's intensive participation in the main bodies defining those standards (Cospas-Sarsat (for the basis of use of SGB / RLS / emergency locator transmitter with distress tracking (ELT-DT) beacons), RTCM (for the additional rules applying to personal locator beacons and emergency position-indicating radio beacons), the Radio Technical Commission for Aeronautics / EUROCAE (for the ELT-DT) and ARINC (for the connectivity part of the ELT-DT)), and achieved through face-to-face discussion with the various committees, active participation in correspondence working groups and presence at the Cospas-Sarsat councils.

Standardisation activities developed during project implementation

Due to the revised schedules for the second-generation Medium Earth Orbiting SAR System in the Cospas-Sarsat organisation, including the SGB timeline, the initial plan (as contracted in the grant agreement) required a recovery plan to allow the European GNSS Agency and the consortium to deliver type-approved devices. Standardisation activities and technology were also incompatible with the development of the Satcom Recorder ELT as an approved product, and were transferred to an activity demonstrating the capabilities of the authorities, still covering both distress tracking and flight recorder data recovery by data streaming. The Galileo Command Service for Remote Activation and Deactivation has been designed and tested in demonstration activities because of the European Commission's schedule for the availability of the service for customers (currently scheduled for 2023).

The Cospas-Sarsat technology had to stay at first-generation level (as the infrastructure was not ready to support the second generation), but SGB demonstrators were designed and built to provide test vehicles. This was achieved with strong cooperation with one major stakeholder in the project (CNES). In this context, Helios project activities still continue beyond the initial lifetime of the project thanks to adjustment of the work plans defined during 2018 and 2019 to meet developing market requirements.

Project results, outcomes and impacts

The products and demonstrators developed within Helios provided innovations that pushed the state of the art in terms of the products brought to the market. In particular, they pushed:

- access to the Galileo navigation signals for SAR;
- access to the Galileo Return Link service by users in maritime and land sectors;
- an aviation device also able to be triggered in flight, in addition to current state-of-the-art devices, which can be triggered only upon a crash;

- an aircraft fuselage antenna able to offer Cospas-Sarsat bi-generation compatibility and access to global navigation satellite system signals and the Iridium constellation to send both an alert signal and flight data parameters over the air in multiple channels.

As initially defined in the Helios project, the social impacts are mainly based on two key factors.

- The users in distress will know that their alert has been detected and located thanks to the Galileo Return Link service in maritime and land environments. This should limit survivor panic and dangerous inappropriate decisions by the users themselves, and potentially by the SAR forces.

- The capability to get the location of an aircraft in distress in flight and on the ground will aid SAR teams to reduce the uncertainty of the position and to assist the Bureau of Investigations to find the wreckage and data recorders rapidly for a better understanding of the circumstances surrounding the accident.

Lessons learned – success factors, challenges and elements of good practice

It is extremely important to have strong and regular technical participation in the different applicable standardisation bodies' forums. Each participant has a specific interest (authorities, industrial companies, SAR forces, standardisation bodies). This requires considerable investment in travel, time and expert resources, if European industry seeks to remain at the cutting edge of technology development, as this is key to understanding the different drivers of the changes that are happening. It can come from market needs, enforcement of better safety, changes in use cases, technology availability, etc.

The human factor in all these discussions is a key element and requires meeting the different parties involved face to face. In the future, travel restrictions, such as we saw due to the COVID-19 crisis, will be one specific hurdle that will require special care.

Case study 19: Project no 769255 GIS-based infrastructure management system for optimized response to extreme events of terrestrial transport networks (Safeway)

CORDIS: https://cordis.europa.eu/project/id/769255

Project website: https://www.safeway-project.eu/en

Start date: 1 September 2018

End date: 28 February 2022

Technology field: transport

Horizon programme line: Societal challenges – Smart, green and integrated transport

Keywords: resilience to disasters; transport infrastructure; risk assessment; big data; smart ICT

Project and standardisation element in brief ('abstract')

GIS-based infrastructure management system for optimized response to extreme events of terrestrial transport networks (Safeway) aims to significantly improve the resilience of transport infrastructure, developing a holistic toolset with transversal application to anticipate and mitigate the effects of extreme events in all areas of the disaster cycle.

Safeway will result in substantial improvements to risk prediction, monitoring and decision tools, contributing to better anticipation and prevention of extreme events, and preparation of critical assets, reducing damage. It incorporates internet technology (IT) solutions into emergency plans, and real-time optimal communication with operators and end users (through crowdsourcing and social media). It improves precision in the adoption of mitigation actions together with new construction systems and materials, contributing to the resistance and absorption of the damage impact.

The main expected impacts are at least a 20 % improvement in mobility and at least a 20 % lowering of costs for infrastructure maintenance.

What the project is about

Safeway's main aim is to design, validate and implement holistic methods, strategies, tools and technical interventions to significantly increase the resilience of inland transport infrastructure. Safeway leads to significantly improved resilience of transport infrastructure by developing a holistic toolset with transversal application to anticipate and mitigate the effects of extreme events at all phases of the disaster cycle: preparation, response and recovery, and mitigation. Within these dimensions, Safeway will:

- implement novel technologies that provide a new, multiscale monitoring approach by combining existing remote sensing technologies to predict the impact of extreme events;

- use crowdsourcing and exploit social media infrastructure to monitor human response during and immediately after a natural or human-made extreme event;

- develop the framework for decision-making considering the abovementioned factors for both single-mode transport (road or railway) and multimodal contexts;

- integrate this multidisciplinary approach through a modular cloud-based ICT platform that provides optimal interfacing among the different components of Safeway's resilience solution.

History and genesis of the project, with a focus on how standards / standardisation needs were identified and conceptually tackled

In the context of standardisation, the expectations of the Safeway consortium at design phase were to:

- provide an overview of existing technical standards and ongoing standardisation activities in the construction and safety regulation of transport infrastructure;

- implement existing open data interoperability standards for the infrastructure information model of the Safeway platform, which was to be done in collaboration with Safeway's advisory board (AB) and clustering with other organisations (e.g. the Open Geospatial Consortium and buildingSMART International);

- reach policymakers and public bodies through Safeway's AB to influence existing and future regulatory processes by advising on new policies and directives;

- define the consortium's standardisation needs to support the identification of standardisation potential.

While the consortium includes no expert partners in the domain of standardisation, many researchers in the consortium are used to working with existing standards that, in many cases, are obsolete for the solutions being developed within the Safeway project (due to its low TRL). Due to the nature of the project, which has a major focus on research, standardisation aspects did not play a relevant role in the design of the project or during implementation. Nevertheless, for the activities being developed, the partners involved are considering current standards, or gaps in current standards, to take into account when developing solutions in the project. During the proposal writing, a task dedicated to standardisation aspects was considered and eventually agreed on. For some of the WPs, it would be relevant to revise existing standards, or provide solutions following the latest developments of candidate standards (e.g. Industry Foundation Classes modelling, or construction-related activities). At the design phase of the project, there were no direct links to any TCs; it only identified relevant organisations to follow up the forthcoming standards.

Standardisation activities developed during project implementation

Since the beginning of the project, the Safeway consortium has been working on identifying relevant stakeholders or international platforms that contribute to the development of standards. Various experts contributing to these standardisation-related organisations were invited to meetings of the Safeway AB, to keep them informed about the proposed solutions and gather feedback from a standardisation perspective. All AB members explicitly agreed to collaborate with the project.

During project implementation, the strategy for standardisation activities was set through a dedicated activity, which was presented in a public deliverable of the project. The specific activities set in this strategy are:

- A1: identification of standardisation needs in the consortium;
- A2: identification of existing technical standards and ongoing standardisation activities relevant to the Safeway project;
- A3: identification of relevant standardisation bodies;
- A4: comparison of outcomes through reviewing existing standards and ongoing standardisation activities in relation to Safeway to define the standardisation potential;
- A5: contribution to data interoperability standards, based on the implementation of open standards in infrastructure information model (T3.3);
- A6: organisation of two parallel events and one standardisation workshop.

During project implementation, no direct interaction with standardisation stakeholders has taken place to date. As mentioned, the results achieved during the project's life are at a very low TRL that prevents them from being shared directly with standardisation bodies. Thus, the consortium is not participating in ongoing standardisation activities. Nevertheless, the project established collaboration and discussion with other ongoing projects and actions, which are recruiting knowledge and practices to contribute to forthcoming standards.

Project results, outcomes and impacts

Safeway results related to standardisation include (all have already materialised):

- information models about transport infrastructure, which might be a contribution of the Safeway project to data interoperability standards, policies and/or directives;
- reconsideration of emergency management plans, to identify the limitations of the current application procedures and requirements for product approval in line with standards and regulations;
- definition of standardisation needs in the construction sector/field in general, and transport infrastructure in particular.

Even though the project is still at too early a stage to quantify the impact of adopting standardisation strategies, it has been found that the adoption or consideration of future standards has allowed for creation of solutions and products that are more likely to be accepted by the industry.

CWAs have not been considered in the project yet. Due to the nature of the project itself, standardisation-specific outputs are not deemed relevant, and the project has not contributed to the revision or development of a specific standard. One indirect output that can be noted is the fact that some of the project deliverables are being considered as relevant new knowledge for other actions focused on assisting the European Commission to draw up a new mandate for CEN.

The sustainability strategy to maintain the results beyond the lifetime of the project has not been defined yet. Nevertheless, as the project outcomes generally have low TRLs, the consortium is considering extending the outcomes to IAs, to reach higher TRLs.

Lessons learned – success factors, challenges and elements of good practice

The elements of the standardisation strategy defined in the project include a list of activities, which can be considered a good practice when starting the implementation of a project. It is also crucial to identify all the standardisation bodies related to the activities of the proposal, so that solutions are driven to comply with existing or future standards. At the same time, involving relevant experts in the AB ensures that the solutions can materialise in practice, helping compliance with national or international codes or open-source communities.

Case study 20: Project no 871533 Zero-touch security and trust for ubiquitous computing and connectivity in 5G networks (5GZORRO)

CORDIS: https://cordis.europa.eu/project/id/871533

Project website: https://www.5gzorro.eu/

Start date: 1 November 2019

End date: 31 October 2022

Technology field: space

Horizon programme line: Industrial leadership – Leadership in enabling and industrial technologies – ICT

Keywords: 5G; artificial intelligence; AI; automation; telecommunications; wireless

Project and standardisation element in brief ('abstract')

5GZORRO is a project that develops solutions for zero-touch service, network and security management in (ubiquitous) multi-stakeholder environments, using smart contracts based on distributed ledger technologies (DLTs) to implement required business agility. The key items to be delivered by the project include marketplace and automation of service setup and AI-driven decisions on service optimisation. The project rests on three main building blocks: AI/zero-touch, DLTs and cloud-native technologies. The research results of the project are being validated by three use cases in 5GBarcelona and 5TONIC/Madrid test facilities.

In terms of standardisation, the project aims to issue open-source software and release it to the community. To this end, the project liaises with SDOs, NSBs and TCs, particularly with the ETSI industry specification groups (ISGs) on permissioned distributed ledgers (ETSI PDL), experiential networked intelligence (ETSI ENI), multi-access edge computing, and zero touch network and service management (ETSI ZSM). The specific project partners represented in these TCs or groups contribute to the review and revision of the defined standards by demonstrating proof of concept (in the specific area) to argue the viability of a given standard.

What the project is about

5GZORRO uses distributed AI to implement cognitive network orchestration and management with minimal manual intervention (zero-touch automation). DLTs are adopted to implement flexible and efficient distributed security and trust across the various parties involved in a 5G end-to-end service chain. With these, the project will implement an evolved 5G service layer for smart contracts among multiple non-trusted parties, to allow service level agreement monitoring, spectrum sharing, and intelligent and automated data-driven resource discovery and management. The cross-domain security and trust orchestration, coupled with service life cycle automation, offered by the project have the potential to enforce security policies in multi-tenant and multi-stakeholder environments.

The project targets stakeholders, such as telecom operators, vertical slice owners/operators, spectrum owners, regulators and passive/active facility owners, many of which are in a consortium of the top 13 5G players from seven EU Member States.

History and genesis of the project, with a focus on how standards / standardisation needs were identified and conceptually tackled

Standardisation targets were identified at the beginning of the project, and liaisons with SDOs and relevant ICT stakeholders were established from the beginning through already participating partners. The main goal was to increase the impact of the project through the standardisation of solutions, and influence the development of standards. The means vary, from the use of project demonstrators to validate standards proposals, to direct contributions to studies and specifications.

The baseline for the selection of and outreach to specific standardisation activities and groups is related to the either active or chairing roles of many project partners, which are large or medium-sized industrial players contributing to the abovementioned ISGs (e.g. those of ETSI). The inspiration coming out of those TCs and groups has been communicated to the project via the dedicated partners and converted into corresponding project tasks, which aim to align with the current standardisation activities discussed and implemented by these bodies. Due to the active participation of some project partners in specific standard-setting bodies and groups, the project has been made well aware of the community discussions on the topic, and can promote the project results and outputs for wider discussion inside the community, whenever possible.

SDOs were not targeted as partners, as they are generally considered more umbrella organisations for big players, which need to be open to the wider community and not dedicated to a specific project or consortium. The project has its own ambassadors (in the form of dedicated partners, people involved in those ISGs), who are invited to make their contributions and communicate the relevant results and research ideas of the project to wider communities and stakeholders. This mechanism for interaction with SDOs and TCs has (so far) been efficient, given the regular follow-up activities initiated by those standard-setting bodies and dedicated project partners, as well as consideration of the Sustainable Development Goals in the overall project, reflected in diverse event participation invitations and promotion of the project for visibility within the wider stakeholder community.

Standardisation activities developed during project implementation

Standardisation activities are reflected (as a dedicated task) in the Outreach WP on communication, dissemination and standardisation. The standardisation activities during this first phase of the project (in the first 18 months) have essentially been focused on setting the foundations for future contributions, beyond the initial task of identifying relevant and reachable standards initiatives.

The project's efforts on standardisation have so far centred on three main areas:

- consolidating the leadership in ETSI PDL;
- supporting the chartering of new standards work in ETSI ENI and ETSI ZSM suitable for hosting contributions from the project;
- consolidating the different standards proposals around the emerging autonomous network concepts within ETSI ZSM and ETSI ENI.

Apart from this, the mechanisms for reporting and tracking standards activities were put in place using the project's collaborative environment.

To date, the following new standards or revisions have been proposed in different SDOs as part of the project.

- **ETSI PDL:** The project contributed to ETSI PDL009 (report on federated data) and ETSI PDL010 (report on DLT offline operations).

- **ETSI ENI:** The project facilitated the approval of work items on intent models (ENI023), the analysis of control loop architectures (ENI027) and knowledge representation (ENI029), and contributed its network slice and service orchestrator / vertical slicer to proof of concept no 09 on autonomous network slice management for 5G vertical services.

- **ETSI ZSM:** Project partners gave a presentation to the ISG with the specific goal of addressing the growing interest in autonomous networks, and more specifically in the multidomain scenarios being considered in this group. The main target will be the realisation of proofs of concept regarding the application of multidomain control loops and service categories.

Project results, outcomes and impacts

Like many other activities, the 5GZORRO impact creation plan also suffered from the impacts of the COVID-19 pandemic, particularly the resulting limitations to networking and showcasing opportunities in cardinal events of the 5G community (MWC2020, EUCNC2020, ICT2020, etc.). In fact, many scheduled events since February 2020 have been cancelled or changed to virtual programmes, with most activities limited by *force majeure* to remote presentation of accepted papers. The 5GZORRO plans for MWC2020, EUCNC2020 and ICT2020 exhibitions were completely thwarted by last-minute cancellations of planned showcases at booths, removal of workshop sessions and overall reduction of programmes. Despite the effects of the pandemic on the outreach plan, the 5GZORRO consortium refocused the objectives and actions for impact creation for its first reporting period (months 1–18), by generating a significant number of valuable results, such as a number of scientific and mass media publications, participation in WGs of TCs and events organised by them, and contribution to the current standardisation activities of various ISGs and SDOs (e.g. the Internet Research Task Force, the Internet Engineering Task Force, the Radio Spectrum Policy Group). There were also a number of jointly exploitable assets identified for potential future contributions to SDOs or open-source communities with proof-of-concept demonstrators.

Lessons learned – success factors, challenges and elements of good practice

One of the success factors outlined by the project is the tangible metrics (KPIs) of standardisation activities, including, for example, the number of SDOs and standards targeted and contributed to. Another contributing factor is the existence of influential industrial representatives in the targeted TCs and standardisation groups to help organise the dissemination of project results and research outputs in an efficient way.

Timing issues have also been considered a major hindrance to standardisation activities, in terms of high expectations about the adoption/revision of a specific standard, which often take more time than the timespan of the project. Standardisation impact should therefore be measured at programme level, and over a timespan of 4–6 years, instead of on a per-project basis, to measure the collective success of a programme in generating certain standards. Individual projects can be better at establishing the groundwork and paving the way for the creation of a research baseline for promoting the importance of the topic and elaborating on the specifications, which can then be considered when reviewing or setting the standard.

An important risk factor mentioned was the emergence of de facto standards from the open-source communities, which risk poor governance if a truly FOSS model is applied. Typically, it is common to have reference standards in the network domain because of the truly interworking nature of networks. An extreme FOSS approach can generally lead to high proliferation of redundant solutions and potential high variation of interfaces, protocols and solutions from the more traditional SDO-driven specification initiatives. In fact, the most successful open-source communities working on network technologies adopted specific governance models and membership-based contribution schemes, which make them more like traditional SDOs.

Case study 21: Project no 779899 Predictive security for IoT platforms and networks of smart objects (SecureIoT)

CORDIS: https://cordis.europa.eu/project/id/779899

Project website: https://secureiot.eu/

Start date: 1 January 2018

End date: 31 December 2020

Technology field: space

Horizon programme line: Industrial leadership – Leadership in enabling and industrial technologies – ICT

Keywords: cybersecurity; internet of things (IoT); security system architecture; use cases

Project and standardisation element in brief ('abstract')

The Predictive security for IoT platforms and networks of smart objects (SecureIoT) project aimed to make internet of things (IoT) devices and communication between them cybersecure. SecureIoT provided implementations for security data collection, security monitoring and predictive security mechanisms, and offered integrated services for risk assessment and compliance auditing against regulations and directives (e.g. the GDPR, network and information systems regulations 2018 and e-privacy regulation), as well as support for IoT developers. The starting point for the development of the SecureIoT framework and architecture was state-of-the-art standard-based IoT architectures and services, as well as blueprints and standards developed in the scope of the Alliance for IoT Innovation and the IoT-European Platforms Initiative.

What the project is about

The overall project goal was to design dynamic, scalable, decentralised and intelligent IoT security mechanisms. These are in high demand in the industry to secure a whole new range of IoT applications that transcend the boundaries of multiple IoT platforms, while involving autonomous interactions between intelligent cyber-physical systems and networks of smart objects. To do so, the project aimed to:

- predict and anticipate the behaviour of IoT systems;
- ensure the security of IoT systems (platforms, applications) through the identification of trustworthy behaviour of IoT devices and establishment of secure IoT services;
- facilitate compliance with security and privacy regulations;
- provide application programming interfaces and tools for trustworthy IoT solutions.

History and genesis of the project, with a focus on how standards / standardisation needs were identified and conceptually tackled

The standardisation-related needs targeted by the project at the conceptualisation stage mainly related to the revision and/or development of a standard framework (which was not

established, or at least was not solid) for ensuring the cybersecurity of IoT and intelligent IoT domains. To this end, the project relied on consortium members (e.g. Fujitsu, Siemens, Intrasoft) that were deemed to be strong industrial players and could provide access to the specific TCs and groups (due to their presence in them) to push forward the project findings/outcomes in the identified standardisation groups/committees. At the very beginning of the project, the decision was made to follow the standardisation direction taken by the leading industrial player in the IoT area (Fujitsu Netherlands), which was also a consortium member, in line with the overall stream of the standardisation activities initiated and discussed in the respective groups and TCs. It was mostly because of the presence of a dedicated project partner (a strong industrial player involved in identified TCs and groups, and providing interaction with them during the project's lifetime) that the direct involvement of the TCs and standardisation groups in the project could take place; this was not foreseen at the beginning.

Standardisation activities developed during project implementation

Standardisation activities were aggregated into a single task of the project, which was considered sufficient to reflect the dedicated efforts. The external stakeholder (at local level) consulted for standardisation activities contributing to Industry 4.0 was Fraunhofer.

During the first 1.5 years of the project, implemented standards, and standardisation activities running in the targeted field and discussed at the specific TCs and groups (apart from those initially targeted by the project), were scanned to identify the gaps and needs to be covered. During the weekly calls of the consortium, Fujitsu (as a leader of the standardisation-related task incorporated in the communication and dissemination WP, and a member of the targeted standardisation groups and committees) reported on the status and progress of interaction with TCs and groups in terms of the project-promoted standardisation activities. These activities mainly related to the new architecture design for the IoT domain focused on security aspects. In this context, interaction with dedicated standardisation committees and groups was not frequent during the project's lifetime.

Project results, outcomes and impacts

The main project outcomes are presented on the project website, and include various services, including the IoT Security Knowledge Base, risk assessment and mitigation, and support in IoT security development and compliance auditing.

In addition, three use cases are described in the datasets (both collected and produced by the project) that were also uploaded on the project website, not only for direct commercial purchase, but also for individualised use by interested organisations. The development team provides those organisations with instructions and support. The results achieved within the project cycle can be associated with TRL 6 or 7. Overall, it is believed, the standardisation activities performed during the project contributed to an increased TRL level, for example in providing reference standards for security architecture design and its further enhancement.

The project's impact on a potential industrial stakeholder was illustrated through the three use scenarios (for dedicated industrial partners of the consortium) by presenting the quantitative and qualitative benefits of the SecureIoT deployments, including rough estimates of useful financial and business KPIs, as well as a cost–benefit analysis. The wider impact of the project includes better understanding and alleviation of security concerns associated with the industrial IoT in multiple sectors and actors in the value chain, thereby acting as a catalyst for realising the socioeconomic benefits and impacts of Industry 4.0 and the digitalisation of industry in general. The project's impact also spans several industries, such as healthcare and autonomous vehicles, and research community stakeholders, offering new solutions to secure the IoT environments deployed and operated in these sectors.

Lessons learned – success factors, challenges and elements of good practice

The standardisation-related success factors and lessons learned outlined in this project can be summarised as follows:

- specific challenges, gaps and issues in terms of contribution to standardisation activities should be identified at the conceptualisation stage of the project in order to address them in a targeted way through a dedicated project task/activity;

- the project consortium should include a dedicated partner (preferably a strong industrial player) that has access to and regular communication with relevant standardisation groups and committees, knows the area and associated missing parts very well, and can promote the project findings in the overall work stream of related standardisation activities;

- the consortium should also keep a balance in terms of involving SMEs, start-ups, research organisations and universities;

- more time might be needed to investigate the existing standardisation work that has been (or is currently being) performed at identified TCs or groups, to smoothly accommodate the project's contribution into the overall direction of standardisation activities in a given sphere.

Case study 22: Project no 101004145 Dynamic spectrum sharing and bandwidth-efficient techniques for high-throughput MIMO satellite (DynaSat)

CORDIS: https://cordis.europa.eu/project/id/101004145

Project website: https://www.dynasat.eu/about-dynasat/

Start date: 1 December 2020

End date: 31 March 2023

Technology field: space

Horizon programme line: Enabling advances in space technology; Future internet: Software, hardware, infrastructures, technologies and services

Keywords: bandwidth-efficient transmission; satellite access; 5G ecosystem; terrestrial and non-terrestrial networks

Project and standardisation element in brief ('abstract')

The novel bandwidth-efficient methodologies for satellite systems (DynaSat) project is researching and developing numerous novel bandwidth-efficient transmission methodologies to be used by advanced non-geostationary satellite orbit (NGSO)-based satellite access infrastructures capable of servicing mass-market and professional 5G users and equipment. The non-terrestrial component of 5G is standardised under the 3rd Generation Partnership Project (3GPP), and DynaSat has assigned a dedicated task to contributing to 3GPP standardisation activities. Another project activity will be to contribute to the ETSI Secured Communicating Solutions and Satellite Communications and Navigation WGs. Contributions to these groups are mostly implemented via three dedicated project partners, which are members of the corresponding groups at 3GPP and ETSI. The project also envisages adopting a monitoring function as part of targeted WGs and organisations (particularly 3GPP). This will help with fine-tuning the standardisation-related project activities and aligning them with the overall work streams followed by organisations and TCs.

What the project is about

The DynaSat project aims to investigate, develop and demonstrate bandwidth-efficient transmission techniques for an advanced NGSO-based satellite access infrastructure, servicing mass-market and professional 5G user equipment (e.g. handsets) in unserved or underserved areas.

The project will leverage 3GPP's ongoing efforts on the definition of the necessary features (Release 17) to enable 5G user devices and the NG Radio Access Network to support satellite operations, and on the development of an ambitious constellation to meet the requirements of mobile network operators' and vertical stakeholders (such as the public safety and transport sectors).

As the traffic demand keeps increasing, this project will also develop selected bandwidth-efficient transmission techniques, such as multiple input, multiple output (MIMO), dynamic spectrum access, frequency reuse, user clustering, coordinated multipoint and interference mitigation, which will allow the network infrastructure capacity to be scaled and share

spectrum with cellular networks. Exploiting the research results, the consortium will contribute to 3GPP Release 18 by promoting and then defining new features in the 5G standard.

History and genesis of the project, with a focus on how standards / standardisation needs were identified and conceptually tackled

The European Commission's Communication to the European Parliament, the Council, the European Economic and Social Committee, and the Committee of the Regions 'Connectivity for a competitive digital single market – Towards a European gigabit society' (COM(2016) 0587 final) set ambitious goals for deploying smart and sustainable networks and services for the success of Europe's digital economy. Satellite communication systems are fundamental components supporting these goals. The DynaSat project aims to address maximisation of the spectrum usage for mobile services in next-generation multiconstellation satellite networks (i.e. NGSO constellations) in support of traffic demand over extremely extended coverage for 5G, beyond-5G and 6G systems.

Targeting specific standardisation groups and their activities at the conceptual stage of the project was based on the relevant expertise of the consortium, which dates back to 2001 and deals with integration of satellite communication into terrestrial cellular networks in order to serve industrial market needs. SDOs and corresponding TCs were not expected to be directly involved in the project initially, partly because they (3GPP in particular) were considered to be out of reach for the project itself, and partly to avoid restricting the freedom of the consortium to frame and investigate the technologies, which might not necessarily be standardised but might serve the individual industrial users to increase their competitiveness in the market.

Standardisation activities developed during project implementation

One of the DynaSat proposal developers (an engineer at Thales Alenia Space France), who is a project partner responsible for standardisation of the non-terrestrial component within 3GPP, is also chairman of the ETSI Secured Communicating Solutions and Satellite Communications and Navigation WGs. In this sense, the project takes leadership of activities in field-related SDOs (3GPP and ETSI), which have comprehensive knowledge of the project content and the standardisation activities covered. The project has two tasks devoted to standardisation, which include plans for contributing to the targeted standardisation topic discussed at SDOs, and are associated with project deliverables D.6.2 'Standardization & regulatory action plan' and D.6.6 'Standardization and regulatory report'. Interaction with TCs and standardisation groups is well informed (mediated by a partner involved in those groups and committees) and helps to consider any modifications happening at SDOs for updating dedicated project activities.

Project results, outcomes and impacts

The project is still in its inception phase, so it is too early to discuss the results and impacts. Given the technically sensitive information (related to specific technological results and outcomes) that is generated by the project, however, each publication released to the public needs to be approved by the security advisory board, as required by the European Commission.

Despite this, it should be noted that the products/technologies developed by the end of the project will have TRLs of 4 or 5 (for some specific technologies), implying the opportunity for lab demonstration during major global events, such as Global World Congress 2023 and WCNC 2022.

The main results expected to be achieved by the end of the project include:

- enhanced life cycle cost reduction (including manufacturing and operations) and increased performance, resulting in greater competitiveness of the European space manufacturing and service industry in the rapidly evolving field of satellite communication;

- development of European research and technology ecosystems consisting of different parties involved in satellite communications (i.e. manufacturers of user equipment, ground segment technologies, service providers and operators, validation and simulation tool developers, and end users);

- greater integration of satellite communications into 5G;

- greater industrial relevance of research actions and outputs, as demonstrated by deeper involvement of industry, including SMEs, and stronger uptake of research results.

The wider impacts envisaged by the project can be summarised as follows:

- contribution to the discussion at the level of standardisation (in both 3GPP and ETSI) regarding adaptation of technologies and algorithms that are currently being used for terrestrial to satellite systems;

- creation of a study item and opening of a discussion around specific technologies investigated within the project to raise awareness about possible standardisation approaches in terms of the satellite component, involving creation of a list of technologies that need to be standardised to enable the use of technologies that are being developed (in different ways) within the project or by other stakeholders;

- having project members join regulatory bodies to boost the technologies developed within the project.

Regarding the project's sustainability, it is believed that the contribution to standardisation groups and committees extends the scope of the project, provided that several partners in the consortium are members of those groups and will continue to keep up with the standardisation activities carried out in dedicated SDOs. It is also noted that the technologies (to be standardised) promoted through the project are research topics unique to most of the partners, which have been investigating them over the last decade, so further similar studies are likely to continue.

Lessons learned – success factors, challenges and elements of good practice

Potential success factors contributing to standardisation activities in EU projects, as well as some lessons learned, include the following.

- Standardisation activities need to be thoroughly designed at the conceptual and inception phases of the project. There might be a call requirement for having such a component (standardisation), but, depending on the proposal subject, it could be mandatory or non-mandatory to account for standardisation activities. There should be a dedicated task/activity/WP linked to measurable indicators, for progress tracking and accounting.

- Success cannot be perceived solely as the acceptance of a technology into a standard, rather than contribution to the development of a standard. It is more important how many organisations and members of a TC support your technology, even if it is not being accepted or standardised.

- Big industrial companies greatly influence the standardisation strategy at a given TC or standardisation group, so it is important to liaise with big industrial players about the standardisation activities designed by the project and constantly monitor updates in their overall strategies.

Case study 23: Project no 871149 Europlanet 2024 research infrastructure

CORDIS: https://cordis.europa.eu/project/id/871149

Project website: https://www.europlanet-society.org/europlanet-2024-ri/

Start date: 1 February 2020

End date: 31 January 2024

Technology field: space

Horizon programme line: RIA

Keywords: planetary science; transnational access; TA; datasets; virtual access; VA

Project and standardisation element in brief ('abstract')

The Europlanet 2024 research infrastructure (RI) will provide the pan-EU infrastructure needed to address the major scientific and technological challenges facing modern planetary science and strengthen Europe's position at the forefront of space exploration. The standardisation element within the project is reflected in activities aimed at standardisation of the documented databases established within both the preceding/contributing projects and current project implementation. It deals with developing common modules of data collection and interpretation for geospatial missions and related activities, including metadata preparation, methods, uncertainties, experimental procedures, etc.

What the project is about

The Europlanet 2024 RI builds on the foundations of a series of highly successful EU-funded projects that have created the leading virtual observatory for planetary data, and the largest, most diverse collection of field and laboratory facilities capable of simulating and analysing planetary environments in the world today. It will provide transnational access (TA) to an enhanced set of world-leading field and laboratory facilities, virtual access (VA) to state-of-the-art data services and tools linked to the European Open Science Cloud, and networking activities to widen the user base and draw in new partners from underrepresented states, non-EU countries, and industry and interdisciplinary fields, and to train the next generation of RI leaders and users.

The project has 57 beneficiaries from both academic and industrial sectors, providing access to over 40 TA facilities on five continents and 4 VA services linking over 100 data services and catalogues.

History and genesis of the project, with a focus on how standards / standardisation needs were identified and conceptually tackled

The Europlanet 2024 RI builds on the foundations of a series of highly successful EU-funded projects that created the leading virtual observatory for planetary data and the largest, most diverse collection of field and laboratory facilities capable of simulating and analysing planetary environments in the world today.

At the conceptual stage of the project, standardisation was viewed in the context of machine learning and AI-based modelling, which require standardised datasets that can be used by a wider stakeholder community worldwide (China, Russia, the United States, etc.). The major challenge identified at the project's outset was changing people's attitudes (working style) towards data collection, storage and sharing practices (bottom-up approach). To do this, it was necessary to demonstrate the advantages of the proposed approach and collaborate with the leading organisations (such as the National Aeronautics and Space Administration (NASA), the European Space Agency (ESA) and the International Atomic Energy Agency) to approve and push forward the revised and/or newly developed standards. It was also clear that the development/revision of new standards would require ICT teams to function at organisation level in order to handle the newly emerged datasets (e.g. architecture of the databases) based on standard operating procedures fixed under a corresponding standard.

Standardisation activities developed during project implementation

Standardisation activities have been grouped under dedicated project WPs and include common terminology; harmonised research methodology; recommendations and/or requirements for new or revised standards; technical specifications; a standard operating procedure; a technical report; development of a new standard; reference data; reference material; accreditation; and interlaboratory comparisons. The overall standard addressed by the project is cartographic representation, geospatial standards and symbology. The involvement of SDOs and (TCs) is not considered useful for the project, since they do not have field-related scientific knowledge to contribute to the revision or development of a specific standard. However, there is collaboration with European Open Science Cloud programmes, clusters (in terms of adhering to common protocols), etc. Furthermore, international organisations, such as the ESA and NASA, have been involved in the project advisory board. Interaction with SDOs and TCs takes place at lower/individual levels, during workshops, intermediated by individual users who present their standardisation-related requirements and get project support with further liaison with relevant TCs or SDOs.

Project results, outcomes and impacts

The project is still running, so it is too early to talk about results and impacts, but the fact that standardisation of the project-related databases has been achieved (as both revised and new standards) and the younger generation (at undergraduate level) considers it an intrinsic part of research and academic practice (due to education and training mechanisms planned by the project) may speak to the project's success, in terms of standardisation and striving towards sustainability. A collaborative international user base has also been established thanks to the project activities. This is ongoing and will contribute to establishing and developing of the standardisation concept at global level (including partners, such as China and Russia), which in its turn is seen as a major expected impact of the Europlanet 2024 RI that is yet to materialise. Another guarantee of project sustainability is a non-profit association to be established in the coming months based on the project itself.

Lessons learned – success factors, challenges and elements of good practice

Overall, the success factors related to standardisation can be summarised as:

- use of framework programme funding as a means to enter dialogue with SDOs and other leading field-specific organisations;
- acceptance among the user community that standardisation is necessary (by presenting its advantages and the disadvantages of not applying it);

- easy-to-use product/services offered to the user community from the project's outset;

- a change in mindset towards the globalised world and the need to have similarly coded (standardised) datasets, especially in areas reflecting global challenges and needs.

Case study 24: Project no 101003805 European quality controlled harmonization assuring reproducible monitoring and assessment of plastic pollution (EUROqCHARM)

CORDIS: https://cordis.europa.eu/project/id/101003805

Project website: https://www.euroqcharm.eu/en

Start date: 1 November 2020

End date: 31 October 2023

Technology field: environment/sea

Horizon programme line: H2020-EU.3.5. - SOCIETAL CHALLENGES - Climate action, Environment, Resource Efficiency and Raw Materials

H2020-EU.3.5.4. - Enabling the transition towards a green economy and society through eco-innovation

Keywords: plastics pollution; standardising methods

Project and standardisation element in brief ('abstract')

The EUROqCHARM project aims to foster a common European framework to harmonise procedures for monitoring and assessment of plastic pollution by critically reviewing state-of-the-art analytical methods and – taking harmonisation one step further – validating them through an interlaboratory comparison study. In doing so, it brings together prominent laboratories in environmental plastic analysis, which produce certified reference materials to be marketed for at least three of the four target matrices (water, soil/sediment, biota and air) during and after the project's completion. Overall, harmonisation of existing methods is the main goal of EUROqCHARM. The cost of the development of standards (as an integral activity) and the deliverables of EUROqCHARM is EUR 2 million.

What the project is about

In recent years, plastic pollution has become a global environmental and societal concern. Numerous protocols have been developed to monitor plastic debris, but these are rarely comparable. This has hindered the gathering of knowledge on pollution sources, development of monitoring programmes and risk assessments, and implementation of mitigation measures. To develop long-term solutions to reduce plastic pollution, it is essential to establish harmonised methodologies. The EUROqCHARM project aims to address this by critically reviewing state-of-the-art analytical methods and – taking harmonisation one step further – validating them through an interlaboratory comparison study. In doing so, it brings together prominent laboratories in environmental plastics analysis, which produce certified reference materials to be marketed for at least three of the four target matrices (water, soil/sediment, biota and air) during and after the project's completion. EUROqCHARM recognises that harmonisation for large-scale monitoring requires flexibility, comparability and reliability, and thus identifies reproducible analytical pipelines, resulting in a catalogue of procedures for nano-, micro- and macroplastics for the four target matrices. Each pipeline is validated in terms of TRL to decide if further validation is needed (through interlaboratory comparison).

History and genesis of the project, with a focus on how standards / standardisation needs were identified and conceptually tackled

From January 2013 to December 2015, the Clean Sea EU Project took place, addressing the measurement of microplastics. The project results revealed that there was no harmonisation in the technologies and standards used, which meant there was a lack of comparable data and of consolidation in the relevant scientific literature. In line with this outcome, the EUROqCHARM project team – particularly Bert Van Bavel – started to prepare the project proposal. The EU Green Deal was another catalyst for the project. Overall, the EUROqCHARM project team identified an urgent need to harmonise methods of monitoring and assessing plastic pollution.

Standardisation activities developed during project implementation

In terms of the risks and/or difficulties encountered related to standardisation activities, the most notable is that the activities of the standard bodies are not in line with EUROqCHARM, and that the standardisation process at CEN and ISO takes longer than EUROqCHARM's 3-year duration (ending in 2023). The project standardisation deliverables are composed of a harmonised research methodology; a new standard and recommendations and/or requirements for new or revised standards; a proficiency test; workshop agreements; a standard operating procedure; technical specifications; a technical report; reference data and material; certification; accreditation; and interlaboratory comparisons.

Project results, outcomes and impacts

Project results, outcomes and impacts delivered so far

- A roadmap has been produced for harmonised data collection and management. Policy analysis and coherence are integral to it.
- Reference material has been established as one of the key outcomes (needed for blueprints).
- The project has built capacity to implement new standards.
- Harmonised standards are in line with the EU's large-scale monitoring initiatives (on different levels).
- The multi-stakeholder composition of EUROqCHARM puts the group in a unique position to achieve its ambitious goals.
- It has brought out blueprints for standards, and recommendations for policy and legislation, and has supported the establishment of acceptable reference levels and environmental targets.

Envisaged future results, outcomes and impacts

To maximise its impact, EUROqCHARM will also establish and consolidate an operational network for monitoring plastics, stimulating transnational joint actions built on existing and future European and international initiatives through the United Nations Environment Programme and the Arctic Monitoring and Assessment Programme – key international players.

Lessons learned – success factors, challenges and elements of good practice

- Some challenges have also been successes: using webinars instead of physical meetings (while there is less interaction, there are more participants), and hosting regular one-to-one meetings with key stakeholders to keep them informed and onboard.

- It is important to have instrument makers on board, especially in Europe.

- Ways of working have been adjusted in the context of COVID-19, with more effort put into internal communication (i.e. there is more communication than in pre-COVID-19 times, including more regular Microsoft Teams meetings).

- Preparation of the reference materials needed for the interlaboratory studies has faced practical challenges and backlogs related to COVID-19.

- While there is a lot of interest and there are lots of requests to collaborate, these are a challenge to consolidate.

- The digital strategy has been adjusted based on stakeholder mapping, with more activity on Twitter, the project website and ResearchGate, and very little communication on LinkedIn.

Case study 25: Project no 825075 European connected factory platform for agile manufacturing (EFPF)

CORDIS: https://cordis.europa.eu/project/id/825075

Project website: https://www.efpf.org/

Start date: 1 January 2019

End date: 21 December 2022

Technology field: connected factory platform for agile manufacturing

Horizon programme line: H2020-EU.2.1.1. - INDUSTRIAL LEADERSHIP - Leadership in enabling and industrial technologies - Information and Communication Technologies (ICT)

Keywords: EFPF; agile manufacturing

Project and standardisation element in brief ('abstract')

The EU-funded European connected factory platform for agile manufacturing (EFPF) project has developed a federated digital platform to enable the agile manufacturing and personalisation required for lot-size-one and Industry 4.0. The barriers to innovation due to the dispersed nature of existing solutions and issues concerning seamless access, privacy, interoperability and lack of testbeds or experimentation facilities are overcome, providing the infrastructure, tools and support for novel service creation and validations by third parties. Overall costs were covered by the project budget (EUR 16.2 million).

What the project is about

Mass production has led to steep decreases in the cost of goods for consumers around the world. Countering the downsides of mass production, the EU-funded EFPF project is developing a federated platform to enable the agile manufacturing and personalisation required for lot-size-one and Industry 4.0, positioning the EU as an innovation leader on the global stage. In doing so, the project federates a smart factory ecosystem, interlinking four smart factory platforms through an open and interoperable data spine, and addressing the fragmentation of solutions available to European companies by coordinating and orchestrating existing functionalities. To achieve a critical mass that can set up an ecosystem, the base platforms are complemented with industrial platforms, collaboration tools, and smart factory systems and their user communities. The barriers to innovation due to the dispersed nature of existing solutions and issues concerning seamless access, privacy, interoperability and lack of testbeds or experimentation facilities are overcome, providing the infrastructure, tools and support for novel service creation and validations by third parties. Experimentation facilities and funding are provided for SMEs to support innovation in different areas of digital manufacturing.

History and genesis of the project, with a focus on how standards / standardisation needs were identified and conceptually tackled

Eleven projects were funded based on a previous EU-funded project. EFFRA organised a lot of clustering activities to promote synergies, and platforms were invited to network events. Digicor, Composition, Nimble and virtual factory Operating System had the same types of

needs; the project team came up with a federation platform idea and wrote the proposal with one holistic offering (see call information, FOF-11-2016 Digital automation, https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-details/fof-11-2016).

Standardisation activities developed during project implementation

New standards

Documents for the CWA 'European connected factory platform for agile manufacturing interoperability (EFPFInterOp)' are listed in a dedicated project deliverable (see https://www.efpf.org/deliverables).

Risks/difficulties encountered in relation to standardisation-related activities

No risks were encountered. As a project partner, the NSB applied sound risk management and provided clear advice on how to mitigate any risks in relation to standardisation.

Specific actions after the end of the project as a result of the standardisation activities

The partners promoted the CWA drafted in the CEN-CENELEC Workshop EFPFInterOp, the project plan and the standard way of establishing federated platforms.

Deliverables

Among the standardisation tools proposed by CEN-CENELEC are CWAs. These documents are listed in a dedicated project deliverable (see https://www.efpf.org/deliverables).

Suggestions for how the links between research, innovation and standardisation could be strengthened

Awareness of existing standards should be raised; people need to know what exists, and to be aware that standardisation is still an ongoing process.

Project results, outcomes and impacts

Results, outcomes and impacts achieved so far

The federated platform provides opportunities for open innovation, agile collaboration and new developments, and delivers societal and economic value in terms of the creation of new jobs and start-ups in the digital manufacturing space; enhancement of digital skill levels; a safer environment for the workforce in the manufacturing sector; better economic conditions for manufacturing companies; and opportunities for new business activities and increased stakeholder engagement. These can be organised into three groups:

- tangible – development of platform services, infrastructure,
- tangible – pilot application, blog,
- intangible – open calls, 20 new subprojects (with a budget of EUR 2.5 million).

Envisaged future results, outcomes and impacts

The project aims to:

- form a federated technology platform for cross-organisational and cross-sectoral integration, with embedded intelligence and embodied tools and services, to create an industrial ecosystem in Europe;
- enable SMEs to develop and/or integrate different technologies, unlock the value of their data, deploy complementary applications and become more responsive to changing value chains;
- establish an extensible marketplace framework to interlink tool and app stores through intelligent service discovery, matchmaking and recommendation mechanisms;
- create an ecosystem through piloting and large-scale experimentation, including financial and technical support for creation of and experimentation with agile value networks (open call);
- realise scenarios for the extension, maintenance and sustainability of the federated platform and its ecosystem;
- develop a comprehensive adoption strategy to attract a large number of companies to the ecosystem;
- effectively manage and promote the EFPF platform, through the European Factory Foundation, a legally independent non-profit organisation mandated by the EFPF project.

Lessons learned – success factors, challenges and elements of good practice

Success factors and elements of good practice

- Sustainable data spine.
- Good cooperation and sharing of ideas, and a more cohesive vision for the future.
- Open call – the project carried out 20 new experiments and received 120 requests/proposals, of which it had to assess which were the best.
- Effective management and promotion of the EFPF platform by the European Factory Foundation.

Challenges

- Not all partners are at the same stage of their digitalisation strategies.
- COVID-19 and related lockdowns have required rethinking and adjustment of dissemination methods.

Case study 26: Project no 635690 Advanced solutions for assuring the overall authenticity and quality of olive oil (Oleum)

CORDIS: https://cordis.europa.eu/project/id/635690

Project website: http://www.oleumproject.eu/

Start date: 1 September 2016

End date: 30 August 2020

Technology field: olive oil

Horizon programme line: H2020-EU.3.2. - SOCIETAL CHALLENGES - Food security, sustainable agriculture and forestry, marine, maritime and inland water research, and the bioeconomy

Keywords: OLEUM Databank; OLEUM Network; authenticity; quality; olive oil

Project and standardisation element in brief ('abstract')

The Oleum project aimed to generate effective, innovative and harmonised analytical solutions to detect and fight the most common and emerging frauds, as well as to verify the overall quality of olive oils. A team of 21 project partners from 15 countries implemented research activities grounded in the development of new and improved analytical methods, and developed a robust dissemination strategy for effectively sharing results with all stakeholders in the olive oil supply chain, aiming to improve consumer and market confidence, and preserve the image of olive oils on a global scale. The overall project costs were about EUR 1 million.

What the project is about

The Oleum project aimed to:

- detect new markers of the soft deodorisation process;
- identify illegal blends of olive oils with other vegetable oils;
- verify olive oil quality (e.g. freshness, polyphenol content, geographical origin);
- improve the organoleptic assessment with a quantitative panel test, based on current official methods, and supported by tailored reference materials for better calibration of the sensory panels, coupled with rapid screening tools to reduce and facilitate the work of panellists.

Peer laboratories subjected the most promising Oleum solutions to a simplified validation process in conformity with internationally agreed standards. Oleum recreated a realistic deodorisation scenario by producing tailored, soft-deodorised olive oils at laboratory scale to apply analytical solutions to known samples.

History and genesis of the project, with a focus on how standards / standardisation needs were identified and conceptually tackled

In response to scandals in 2013 dealing with olive oil fraud that extended globally, the European Commission, together with the International Olive Council (see https://www.internationaloliveoil.org/), decided to organise a scientific workshop for olive oil authentication on 10–11 June 2013 in Madrid. Many experts working in the field of olive oil authentication, in both International Olive Council member and non-member countries, were asked to work on issues related to procedures, markers and proficiency in the application of methods (see https://www.teatronaturale.it/international/olive-and-oil/29916-scientific-workshop-on-olive-oil-authentication.htm). This workshop highlighted remaining problems with authentication. Hence, the University of Bologna built a core partner group. The consortium increased to 20 partners when an additional partner joined in 2017. The aim was to involve the Mediterranean region, but also partners or advisory board members from Argentina, China and the United States, for example. On 17 and 18 February 2021, the Oleum project successfully held its final conference. In total, over 400 people from different fields registered for the online meeting to hear about the results of the project and discuss future possibilities of ensuring olive oil quality and authenticity (see http://www.oleumproject.eu/news/article/oleum-final-conference).

Standardisation activities developed during project implementation

The risks and difficulties encountered in terms of standardisation-related activities were related to the complexity of methods for validation (definition of final standard operating procedures, training workshops and ring tests). Furthermore, while a simplified validation process was tested and delivered, the COVID-19 pandemic slowed down interlaboratory experiments due to lockdown restrictions. This resulted in a 6-month extension to successfully finish the project and effectively complete all validation activities. The results of the standardisation activities have been followed by specific actions after the end of the project, including proposing methods for International Olive Council and EU regulations to use, and dissemination to other SDOs, such as AOAC International, ISO, the US Food and Drug Administration and the American Oil Chemists' Society, and to olive oil supply chain stakeholders at national and international levels (e.g. by means of seminars, training sessions and presentations to practitioners and the scientific community).

The deliverables are composed of a harmonised research methodology; recommendations and/or requirements for new or revised standards; standard operating procedures; a technical report; proficiency tests; reference data; reference materials; certification; and interlaboratory comparisons.

The links between research, innovation and standardisation could be strengthened by promoting the participation of SDOs in the advisory boards for R & I projects to ascertain their needs in terms of methods and markers and hear their suggestions for effective delivery of methods and materials (in other words, to involve them).

Project results, outcomes and impacts

Results, outcomes and impacts achieved so far

The impact of the Oleum project can be summarised as two waves of innovative analytical methods (all developed within the duration of the project) that are intended for use by regulatory bodies and laboratories at international level in the coming years. The Oleum Network brings together relevant stakeholders in olive oils, to maximise the impact of proposed analytical solutions and enlarge the body of reliable knowledge on olive oil. The Oleum Databank contains all the information from Oleum research and other reliable international sources. It is web based, easily accessible, scalable, constantly updated and available for download.

Both are expected to be maintained in the medium to long term, thus representing a reference for the olive oil analytical field. The project has translated this end goal into a tailored, impact-driven strategy that addresses the major players in the olive oil arena (olive oil industry professionals and quality control laboratories, international regulators and policymakers, and consumers / the olive oil market). Moreover, the CWAs were included as state of the art for some issues.

Envisaged future results, outcomes and impacts

Substantial knowledge and technology transfer activities were envisaged to aid in the implementation of the Oleum Databank and the Oleum Network.

Lessons learned – success factors, challenges and elements of good practice

Major success factors and elements of good practice are:

- careful partnership building of the consortium, which meant it was balanced in terms of stakeholders and geography;
- effective work and dissemination of scientific results;
- avoidance of media noise, cautious communication;
- wide-ranging work on proficiency;
- involvement of many experts, avoiding personalisation;
- involvement of top institutions and scientists in the field.

Some methods and procedures and materials are ready to be up taken by the regulation bodies. The Oleum Databank will be maintained by the JRC and is expected to be updated and populated with new data.

Case study 27: Project no 644962 Privacy and security maintaining services in the cloud (Prismacloud)

CORDIS: https://cordis.europa.eu/project/id/644962

Project website: https://prismacloud.eu/

Start date: 1 February 2015

End date: 31 July 2018

Technology field: commerce

Horizon programme line: H2020-EU.2.1.1. Industrial leadership – Leadership in enabling and industrial technologies –ICT

Keywords: ICT-32-2014 – cybersecurity, trustworthy ICT

Project and standardisation element in brief ('abstract')

The EU H2020 Privacy and security maintaining services in the cloud (Prismacloud) research project is dedicated to enabling secure and trustworthy cloud-based services by improving and adopting novel tools from cryptographic research. The main idea and ambition of Prismacloud is to enable end-to-end security for cloud users and provide tools to protect their privacy with the best technical means possible (cryptography), and work on the further development and/or creation of ICT security / cloud computing standards.

What the project is about

In order to address the challenges to, and enable the implementation of, services with the intended security properties in cloud computing, a set of goals for the Prismacloud project has been identified:

- development of cryptographic tools to protect the security of data during their life cycle in the cloud;
- development of cryptographic tools and methods to protect the privacy of users;
- creation of enabling technologies for cloud infrastructures;
- development of a methodology for secure service composition;
- experimental evaluation and validation of project results.

History and genesis of the project, with a focus on how standards / standardisation needs were identified and conceptually tackled

The standardisation activity, which spanned the entire duration of the project, started with 1 year of analysis, planning and preparation. A standardisation plan, with its own specific tasks and budget, was developed. Standardisation was seen as critical to ensure the success of the project's exploitation and market strategy, as the field of cryptography thrives on standards being open so that they are accepted by the market. Standards are important in

information security for compliance, and were the ideal tool to increase the impact of the solutions developed.

There was relatively little experience in the consortium, but support from the advisory board provided the opportunity to quickly acquire knowledge about standardisation, thus closing any gaps. Three partners from different countries agreed to actively support the process, including through their national committees. In the design/set-up phase of the project, there were very few connections to TCs; the network first had to be established and relevant contacts made nationally. TCs then responded very positively to the contributions from the project. In general, experts from EU projects can provide important contributions.

Connections to national, EU-wide and international standards were established. These alliances have been continuously expanded and improved, and the project managers are still active and well networked today.

Standards in standardisation during implementation

Over the course of implementation, the project team established liaisons with two WGs of ISO/IEC JTC 1/SC 27, 'Information security, cybersecurity and privacy protection':

- WG2, 'Cryptography and security mechanisms', for activities concerning low-level cryptographic primitives;
- WG4, 'Security controls and services', for activities at service level.

The project team participated in the specialist task force ETSI TC Cyber STF5292 for 1 year (March 2017 to February 2018), developing a technical specification for the field of attribute-based credentials.

They attended four of the ISO/IEC semi-annual meetings around the world, and also participated in standardisation work between the meetings.

To secure the project's impact, three project partners sought accreditation through the mirror committees of SC27 of two national bodies (from Germany and Austria). Through these national bodies, the project contributed around 90 comments to the standard ISO/IEC 19086-4 'Cloud computing Service Level Agreement (SLA) framework – Part 4: Security and privacy' of WG4, which defines objectives to be negotiated between cloud providers and customers in a cloud service level agreement . Through the leverage of their national bodies' voting rights, they were able to add several objectives to the standard for the kinds of services and tools that were developed in the project.

In WG2, the project implemented a new system through three of the ISO meetings, proposing and organising a 'study period' on the potential instantiation of a new standard for redactable signatures, one of the core technologies proposed in Prismacloud. Based on positive evaluation and feedback, they proposed a new work item (i.e. to develop a new standard), and finally gained the support of five other national bodies to officially start the new standard ISO/IEC 23264, 'Information security – Redaction of authentic data'.

The project secured continuation of the standardisation activities beyond project end, with Austrian Institute of Technology and the University of Passau declaring that they will remain

active in cloud security and privacy standardisation in ISO SC27, and continue to drive the standardisation activities that sprang from the Prismacloud project.

Project results, outcomes and impacts

Results, outcomes and impacts achieved so far

The project created a toolkit, alongside a portfolio of eight security-enhanced cloud services and software. As a proof of concept to demonstrate a measurable increase in service level security and privacy, Prismacloud developed three case studies based within the fields of smart cities, e-government and e-health.

Prismacloud has succeeded in nudging some of its research results towards higher TRLs, and its data privacy tools are already of interest to IBM. Furthermore, Prismacloud's methodology has been licensed to a start-up company (fragmetiX), which has already released its first product based on the technology.

The results contributed to the standard ISO/IEC 19086-4, and a new two-part standard has been initiated: ISO/IEC 23264-1 and ISO/IEC 23264-2. Part 1 of the standard is already published, while Part 2 is still in progress and being edited. The planned publication date is in 1 year.

The standards make the project results better known in the industry, and they support marketing.

Envisaged future results, outcomes and impacts

The team is further commercialising the project's services, as well as continuing activities towards achieving standardisation of cloud security service levels and advanced digital signatures. See the forthcoming ISO/IEC 23264-2. The topics will be continued as part of new projects.

Lessons learned – success factors, challenges and elements of good practice

Success factors and elements of good practice

Based on the experience of this project, the team is considering standardisation needs in organising itself for new submissions. It is good for standardisation to have partners who are continuously active in relation to the topic and can be productive from the beginning of the project. Active commitment is required, which in turn requires resources. The support of several partners throughout the project's duration was a success factor.

Lessons learned

- Be active from the start of the project and prepare. Planning is necessary at the beginning, with identification of relevant standards.

- Explore opportunities for contributions to various committees (contributions and comments, reviews, active participation). If possible, build on existing networks in line with the issues currently being addressed in the committees.

- Work with partners in the project and proceed in a coordinated manner. Liaise with similar projects and, if possible, take a coordinated approach.

- Prepare for contributions after the project (follow-up financing). Special grants (StandICT.eu) to pursue standardisation projects have also been very useful in the past. The active partners must be able to complete the activities they start beyond the project's duration.

- The offer for experts to participate in standards should have a lower threshold (i.e. the administrative overheads should be reduced). The EU should find ways for projects to easily provide input and send experts without complex processes, thus bringing academic expertise to standardisation bodies for independent contributions and a vendor-neutral view.

Challenges

The biggest challenge was time. The time taken to develop new standards is very long, much longer than the running time of a project. The establishment of liaisons and other opportunities for official participation as experts, and also gaining voting rights, took a relatively long time, which in turn shortened the active phase. The identification of relevant standards under development was also time-consuming.

Case study 28: Project no 636329 Efficient, safe and sustainable traffic at sea (EfficienSea 2)

CORDIS: https://cordis.europa.eu/project/id/636329

Project website: https://efficiensea2.org/

Start date: 1 May 2015

End date: 30 April 2018

Technology field: shipping industry

Horizon programme line: IA: H2020-EU.3.4. – Societal challenges – Smart, green and integrated transport

Keywords: e-navigation; open market; maritime safety

Project and standardisation element in brief ('abstract')

The Efficient, safe and sustainable traffic at sea (EfficienSea2) project created and implemented innovative and smart solutions for efficient, safe and sustainable traffic at sea through improved connectivity for ships. EfficienSea2 has been a demonstrator in the Arctic Ocean and the Baltic Sea, and is the first generation of a coherent e-navigation solution. Through global collaboration, the use of open-source software and an explicit aim of standardised solutions, EfficienSea2 paved the way for a global roll-out of e-navigation. EfficienSea2 has transformed the solutions developed into international standards and globally accepted best practices, where possible. Direct work by partners in standard-setting organisations such as the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA), IEC, International Hydrographic Organization (IHO), ITU and World Meteorological Organization, is an essential output of the project, as is influencing regulatory regimes in the EU and the International Maritime Organization (IMO), in particular.

What the project is about

The overall aim of the EfficienSea2 project was to create and implement innovative and smart solutions for efficient, safe and sustainable traffic at sea through improved connectivity for ships.

Information exchange between ships and the shore is unstable, costly, and marked by old technology and non-standardised solutions. A lack of standardised automated information flow and reporting between ships, owners and the authorities means information about a ship's load, crew and other characteristics has to be given repeatedly to different stations ashore. This increases the risk of accidents, inefficiency and administrative burdens. The need for operational solutions in the maritime domain is, therefore, significant.

History and genesis of the project, with a focus on how standards / standardisation needs were identified and conceptually tackled

Firstly, research for the relevant standards of the project was carried out. This WP was undertaken by IALA, and involved many other organisations responsible for standards (such as IMO, ITU, IHO, ISO, IEC, IACX Energy, CSPT and ETSI).

Cooperation with standardisation organisations was necessary to secure the uptake of developed services, and already began in the application phase of the project. Involvement in the maritime standardisation took place before, during and after the project.

Involvement in standardisation work carries the risk of delays in the development process. Standardisation costs are very difficult to assess but could be about 50 % of the budget.

Many relevant standardisation bodies were directly involved in the project (e.g. ITU, IMO, IEC, IHO and IALA).

Standardisation activities developed during project implementation

The main standardisation activities that took place over the course of the project were:

- the Maritime Connectivity Platform service specification guideline, adopted by IALA in 2017;
- practical experiments with the existing RTZ route format in EfficienSea2, resulting in an updated version, which has been published by Comité International Radio-Maritime (https://www.cirm.org/rtz/);
- specific standards for the VHF Data Exchange System under way in IALA and ITU (final standardisation expected to be finished in 2024);
- accepted contributions to Standard S-101-based sea charts (https://iho.int/en/s-100-based-product-specifications), of which version 5 is planned to be adopted in May 2022;
- development of a standard for navigational warnings and notices to mariners (S-124) (ongoing).

Standards were used to ensure that the solutions developed were available to all end users, regardless of what equipment they were using. The project results led to the development of a standardised service in the maritime domain. The Maritime Connectivity Platform is an open-source technology, a digital maritime domain. It brings common connectivity standards to maritime navigation and transportation systems.

Project results, outcomes and impacts

Results, outcomes and impacts achieved so far

EfficienSea2 has developed essential solutions that are the prerequisites for taking e-navigation from testbeds to real-life implementation: safety- and efficiency-boosting end user services, platforms for services, a ground-breaking Maritime Connectivity Platform and smart communication channels – the first generation of a coherent e-navigation solution.

Various standards (IALA standards G1128 and G1157, IHO S-100) were adopted, updated and put in place (see Section 28.4 above).

A dissemination strategy has been established and implemented.

Envisaged future results, outcomes and impacts

The new platform opens up a new common market for digital service solutions in the maritime domain and will reduce the proprietary market power of, for instance, the manufacturers of electronic chart display and information systems.

Lessons learned – success factors, challenges and elements of good practice

Standards can help research activities during projects with a common terminology or methodology and ensure the success of projects' exploitation and/or market strategies.

EfficienSea2 benefited greatly from having many relevant standardisation bodies directly involved.

Projects should always focus on the main deliverables. If setting standards is the project's goal, all irrelevant parts should be reduced.

Not everything has to be standardised; it would take too much time to standardise everything.

Case study 29: Project no 832800 From mobile phones to court – a complete forensic investigation chain targeting mobile devices (Formobile)

CORDIS: https://cordis.europa.eu/project/id/832800

Project website: https://formobile-project.eu/

Start date: 1 May 2019

End date: 30 April 2022

Technology field: fight against crime and terrorism

Horizon programme line: RIA: H2020-EU.3.7. – Secure societies – Protecting freedom and security of Europe and its citizens; H2020-EU.3.7.1. – Fight crime, illegal trafficking and terrorism, including understanding and tackling terrorist ideas and beliefs; H2020-EU.3.7.8. – Support the Union's external security policies including through conflict prevention and peace-building

Keywords: criminal investigation and prosecution; data recovery; preservation of digital evidence; mobile phones

Project and standardisation element in brief ('abstract')

The Formobile project is building an end-to-end forensic investigation chain for mobile phones to help law enforcement agencies (LEAs) preserve digital evidence for use in court to convict and sentence perpetrators. A new standardised process will provide security and trust in the evidence chain by guiding the LEAs from arrival on the crime scene to the use of digital evidence in court. Therefore, novel tools are being developed to acquire mobile data, unlock mobile devices, and decode and analyse data retrieved. The consortium set out to develop a CWA, providing guidelines for a complete end-to-end mobile forensic investigation chain.

What the project is about

The Formobile project addresses the need for LEAs to access material stored on mobile devices or in the cloud. Often, mobile phones are used by criminals to communicate, plan and execute a crime. This development poses new challenges for LEAs. Encrypted or deleted data such as emails, chat messages, call and web browser histories, contacts and GPS data have to be recovered and prepared for court use. Still, digital evidence is being discarded in court cases due to a lack of standards.

Formobile wants to ensure that the data secured can be used as court-proof digital evidence, and so support criminal investigation and help to convict, prosecute and sentence criminals. In this context, the different legal systems in the various countries must be considered. The project consortium consists of 18 partners, including LEAs, forensic institutes, technical universities, research organisations, ministries (justice and interior), governmental organisations and NGOs, SMEs, enterprise support networks, accelerators and national standardisation bodies. They come from 15 countries: Austria, Belgium, Bulgaria, France, Germany, Greece, Kyrgyzstan, Malta, the Netherlands, Norway, Poland, Portugal, Spain, Sweden and the United Kingdom.

The overall goal, to establish a trustworthy and court-proof complete end-to-end forensic investigation chain, has been split into three objectives:

- create novel tools for acquiring mobile data, unlocking mobile devices, and decoding and analysing mobile data;
- develop a new mobile forensics standard;
- build a training curriculum for police and prosecutors.

History and genesis of the project, with a focus on how standards / standardisation needs were identified and conceptually tackled

Police, public prosecutors and forensic laboratories saw a need to maximise trust and security in the chain of evidence. Here, standardisation as part of a multi-stakeholder process can increase trust and confidence.

On the one hand, the integration of many stakeholders into the consortium (e.g. LEAs, judicial representatives, research institutions, software tool providers and NGOs) combined with the standardisation community enables the use of broad collective knowledge. On the other hand, the stakeholders also represent some new users of standards. Here, qualified feedback on requirements can be obtained, and the first prototypes can be tested. Thus, the systematic, structured and controlled approach within the standardisation framework ensures trust.

Some organisations already have experience with the standardisation process. For organisations without experience, an introductory webinar was offered at the start of the project. In addition to the standardisation process, the benefits of standardisation and participants' roles, tasks and obligations were explained.

Standardisation activities developed during project implementation

The main standardisation activities that have taken place over the course of the project are:

- a survey and a ring trial, used to capture European laboratories' current capabilities in mobile forensics;
- summary of the current criminal procedure;
- summary of existing relevant standards and best practices in mobile forensics, and identification of gaps;
- contact made with TCs to present the project to them, namely CEN-CLC/JTC 13 'Cybersecurity and data protection', ISO/IEC JTC 1 SC 27 'Information security, cybersecurity and privacy protection' and CEN/TC 419 'Forensic science services';
- development of complementary digital tools (for acquisition, decoding and analysis);
- interviews with LEAs and a survey of them, which showed training gaps; a curriculum on mobile forensics has therefore been prepared;
- a CWA on mobile forensics (in progress);

- continuous dissemination activities, such as workshop events, social media posts, newsletters, podcasts and conference participation.

Project results, outcomes and impacts

Results, outcomes and impacts achieved so far

The Formobile project aims to create novel tools for the extraction and examination of mobile data on mobile devices, develop a new mobile forensics standard, and build a training curriculum for police and criminal prosecution.

The project is progressing according to plan. The CWA is ready. The new standard will be presented in February 2022 at the final project meeting, and will probably be published in April or May 2022. Ring trials for the digital tools are running. The training documents have been created, and the first training session has already taken place. A dissemination strategy accompanying the project has been developed and is being pursued. This includes workshop events, social media posts, newsletters, podcasts and conference presentations. Contacts were established with other organisations (e.g. the European Union Agency for Law Enforcement Cooperation, the European Union Agency for Cybersecurity and its digital forensics subgroup, and the US National Institute of Standards and Technology department for computer forensics and software assurance) (as of November 2021).

Envisaged future results, outcomes and impacts

The consortium also set goals for the phase after the project. There will be ongoing promotion of the standard after publication in April/May. Other projects will be sought in which the standardisation work can be continued. New, user-friendly tools for extraction and examination of data from mobile devices are ready for commercialisation. Training of LEAs and prosecution authorities will continue (partially online).

All in all, the project results strengthen the European mobile forensics market and help counter the smartphone black market in Europe.

Lessons learned – success factors, challenges and elements of good practice

Standardisation is a strategic tool and should be used in a targeted manner.

The standardisation process should be explained at the beginning of the project (roles, tasks, responsibilities and resulting benefits). Frequently reminding the consortium partners of the benefits of standardisation (e.g. getting or increasing market acceptance) will increase the consortium partners' commitment.

Standardisation should be assigned to a task or WP. A separate WP increases visibility and relevance.

Considering the long development time of a CWA (approximately 1.5 years) and average planning phase for projects (3 years), the standardisation process should be done at an early stage.

Functional project and risk management enables adherence to the schedule. This can be done through professional support.

Monitoring how standards are used facilitates commercialisation of novel solutions developed by the project after the end of the project.

Standards as codified knowledge can help to bring information to the market and thus prepare the market.

The project plan should state who is responsible for the post-project phase (to ensure that the training programme is further developed and continued, for example).

Case study 30: Project no 733112 Standardisation of generic pre-analytical procedures for in-vitro diagnostics for personalized medicine (SPIDIA4P)

CORDIS: https://cordis.europa.eu/project/id/733112

Project website: https://www.spidia.eu/

Start date: 1 January 2017

End date: 30 June 2021

Technology field: health

Horizon programme line: CSA – Coordination and support action: H2020-EU.3.1. – Societal challenges – Health, demographic change and well-being; H2020-EU.3.1.6. – Health care provision and integrated care

Keywords: pre-analytical workflows; personalised medicine; biomarker; biobanks; diagnostics

Project and standardisation element in brief ('abstract')

The Standardisation of generic pre-analytical procedures for in-vitro diagnostics for personalized medicine (SPIDIA4P) project set out to reduce diagnostic errors based on improper pre-analytical human sample collection, preservation, storage, transport and processing. The development of related standards limits divergent methods and thus helps to control environmental conditions and the various laboratory sample-processing steps prior to the final analytical test. This can reduce variation in the treatment of samples, making the sampling and processing process more reliable. The number of patients' samples that are compromised also decreases, and, as a result, diagnoses improve. In addition, standardisation can make the process more efficient and allows a reliable comparison of data generated by different laboratories.

SPIDIA4P therefore aimed to develop and implement 14 new pan-European pre-analytical technical specifications and international standards.

What the project is about

In the early 2000s, a number of different publications highlighted problems in the context of medical sampling (e.g. due to alteration of cells after sampling). To address these problems, advanced technical methods had to be developed to optimise the sampling process.

In 2006, a large research project was launched in the United States to systematically assess the impact of specific pre-analytical factors on the results of molecular analysis (US National Cancer Institute Biospecimen Research Network). In 2008, the SPIDIA project was launched under the European Commission's seventh framework programme (grant agreement no 222916) for standardising pre-analytical procedures for improving in vitro diagnostics. Both the EU and US initiatives worked closely together. SPIDIA developed several new pre-analytical workflow technologies for preventing post-collection impacts on human specimens and was also able to show that the laboratory error rates could be significantly improved just by setting a few simple pre-analytical guidelines. This scientific evidence enabled a European

standard development initiative via CEN. In 2015, the first eight pan-European pre-analytical CEN technical specifications and ISO international standards were introduced in Europe.

Also in 2015, it was estimated in the United States that about 10 % of all patient deaths are a result of diagnostic errors. The pre-analytical phase was identified as the most error-prone in the entire diagnostic process.

With a focus on personalised medicine, where quality assurance is crucial, SPIDIA4P developed additional pre-analytical standards to broaden the portfolio of molecular diagnostics: an additional 14 pan-European technical specifications and ISO standards, and 13 external quality assessment schemes. The assessment schemes will be used to monitor resulting diagnostic practices in laboratories. The consortium worked together with more than 14 other research consortia to obtain scientific evidence and support for the development of standards. The technical specifications and standards developed also support biomarker discovery, development and validation in biomedical research, and can be used for biobanks.

History and genesis of the project, with a focus on how standards / standardisation needs were identified and conceptually tackled

The reception of the standardisation initiative by CEN and ISO was very positive. The German NSB, DIN, was involved in the project. DIN is a WP leader in CEN/TC 140 and leads the project management office of the TC on behalf of CEN. During the development of the standards, many scientific, legal, organisational and linguistic requirements had to be taken into account. Still, the office responsible at DIN supported the task. The team had complete access to all standards referred to (e.g. quality management and transport guidelines). The project management office of CEN/TC 140 (run by DIN) and ISO/TC 212 helped to highlight all relevant and essential standards, and supported standards development with secretarial and management work.

The consortium members and stakeholders had differing scientific background knowledge and expertise in the standardisation process, which was combined to develop the new specifications and standards. All consortium partners contributed to the project's overall success with specific tasks. This ensured long-lasting commitment. An external project management organisation handled the daily SPIDIA4P administration and reporting work on behalf of the SPIDIA4P coordinator, and supported public relations activities.

Standardisation activities developed during project implementation

The main standardisation activities that took place throughout the project were:

- liaison with several TCs (ISO/TC 212, ISO/TC 276, CEN/TC 140) and other key stakeholders in standardisation such as the US Clinical and Laboratory Standards Institute, the European Organisation for Research and Treatment of Cancer, ESP, the European Federation of Clinical Chemistry and Laboratory Medicine, MedTech Europe and most EU national standards bodies (e.g. DIN, the National Ecological Network, ASI, UNI); the NSB and TCs were essential to developing CEN and ISO standards;

- use of existing standards as a reference for standards development;

- development of 12 new pan-European pre-analytical CEN technical specifications (in the fields of venous whole-blood circulating tumour and organ cells, venous whole-blood exosomes, venous whole-blood cell free-circulating RNA, saliva, frozen

tissues, urine and other body fluids, fine needle aspirates and human specimen microbiome);

- development of two new international pre-analytical ISO standards:
    - formalin-fixed paraffin-embedded tissues (*in situ* staining procedures),
    - metabolomics (urine, blood plasma, blood serum);
- development of 13 new external quality assessment schemes.

Project results, outcomes and impacts

Results, outcomes and impacts achieved so far

The project proceeded according to plan. The developed standards have been implemented at almost all partner sites. They have been disseminated to accreditation agencies, other partner consortia projects and partner organisations, where they are used. The standards are used in case studies for demonstrating that the standards lead to superior molecular diagnostic results and set the basis for developing accompanying EQA schemes. An additional dissemination strategy accompanying the project has been developed and pursued. This includes measures such as training events, presentations to professional associations and at international congresses, webinars, social media campaigns, posters and the SPIDIA4P website.

Envisaged future results, outcomes and impacts

Several CEN/TS standard documents are in progress and will be taken further at ISO to complete the international standards portfolio. The SPIDIA4P website will stay active, and the project newsletter will continue. Support with standardisation will be given to various other H2020 and national projects as well as stakeholder organisations. Implementing the new legislation (Regulation (EU) 2017/746 on in vitro diagnostic medical devices) can be based on the developed standards for its pre-analytical legal requirements. The project won the CEN-CENELEC Project Award in 2021.

Lessons learned – success factors, challenges and elements of good practice

- The standardisation process should start as soon as possible.
- In addition to the consortium partners, all stakeholders affected by the standardisation process should be invited to participate in the project (e.g. professional associations, regulators, or other research consortia and research infrastructures).
- Conflicts with stakeholder groups can be prevented or reduced through timely involvement.
- All partners should be informed about the standardisation process in general terms before the start of the project in order to be able to assess its costs and benefits.
- Demonstrating the benefits (to patients, economic, etc.) is essential to maintaining long-term commitment.

- Participants in standardisation projects should envisage a clear goal that they are pursuing with the standardisation, before becoming part of the consortium. Companies and other organisations should be aware of the benefits but should also carefully consider the commitment required and the impact of participation (e.g. improved market access, improved performance of products and technologies versus costs and time).

- Each standard should have its own project plan.

- Team-building events help to build highly motivated consortia and standard project teams with high long-term commitment.

- SPIDIA4P was so successful because it could build on SPIDIA. Long-term game-changing initiatives need several years to drive the process. These initiatives should use a programme of several projects rather than a single project.

Case study 31: Project no 820999 Advancing resilience of historic areas against climate-related and other hazards (ARCH)

CORDIS: https://cordis.europa.eu/project/id/820999

Project website: https://savingculturalheritage.eu/

Start date: 1 June 2019

End date: 31 August 2022

Technology field: climate change

Horizon programme line: RIA: H2020-EU.3.5.6. – Cultural heritage; H2020-EU.3.5. – Societal challenges – Climate action, environment, resource efficiency and raw materials; H2020-EU.3.5.1.2. – Assess impacts, vulnerabilities and develop innovative cost-effective adaptation and risk prevention and management measures

Keywords: crisis management; disaster risk management; climate change; cultural heritage; historic urban centres

Project and standardisation element in brief ('abstract')

Many cities are already confronted with extreme weather events and their effects. Climate change will increase the number of events even more. The Advancing resilience of historic areas against climate-related and other hazards (ARCH) project aims to establish a collaborative disaster risk management framework, supplemented by a set of methods and tools to support decision-making (for greater detail, see Lindner et al., 2021b). It will enable local authorities, politicians, experts, practitioners and city residents to assess and enhance the resilience of historic areas to climate change and natural threats.

The ARCH project addresses three related problem fields:

- cultural heritage management,
- disaster risk reduction,
- adaptation to climate change.

Four European municipalities (Bratislava, Camerino, Hamburg and Valencia) are partners in the project. The consortium set out to develop one or more CWAs, a technical report and reference material to provide support.

What the project is about

Today, climate change is one of the most severe physical threats to people and their cultural heritage. As a result, there is a need to include better climate change adaptation and disaster risk reduction aspects in heritage management and to utilise better the resilience potential of heritage for climate change adaptation and disaster risk reduction. The ARCH project will deliver a suite of methods and tools to provide better information and support with decision-making for resilience management so that heritage managers, local authorities, urban planners and politicians can assess and improve the resilience of historic areas and reduce the risk of a disaster.

In addition, raising awareness of the consequences of climate change and natural disasters on historic areas is needed, and policymakers need to adapt existing regulations for heritage management to changing conditions. To develop its methods, tools and recommendations, the project has established a co-creation process with local politicians, practitioners and city residents.

Specifically, the ARCH project will develop:

- technological means to analyse the current conditions of cultural objects and historic areas,
- information management systems for georeferenced properties of historic areas and hazards,
- simulation models (e.g. simulating ageing of materials),
- a risk-oriented vulnerability assessment methodology suitable for both policymakers and practitioners, integrated into a web-based decision-support system,
- a pathway-planning tool to visually design implementation plans for resilience measures, based on an inventory of evaluated measures, linked to an inventory of financing options,
- a resilience self-assessment tool to facilitate the resilience management process and strategy development.

The project consortium consists of 16 partners, including European municipalities, universities, research and technology organisations, SMEs and an NSB. ARCH includes the German NSB, DIN, as a partner to prepare materials that ensure the resilience and reconstruction of historic areas and can be progressed systematically through European standardisation. Project partners come from six countries (Germany, Ireland, Italy, Slovakia, South Korea and Spain).

History and genesis of the project, with a focus on how standards / standardisation needs were identified and conceptually tackled

Two dedicated tasks were planned in standardisation. Specific time quotas (person-months) for all partners were allocated to both tasks. In addition, the standardisation coordinator was given time to investigate all other WPs in the project, to exchange information and identify any potential for the use or development of standardisation. The NSB managed the standardisation task. For this purpose, DIN was invited into the consortium.

Some partners have taken part in previous standardisation projects and were able to use and share this experience. They can assess which standardisation products can be produced within a project. Public sector partners (e.g. city partners, some universities) tend not to have expertise in standardisation. Partners have been involved in the standardisation process at different levels (including committee level) with varying intensities. For example, multiple project team members are working on several DIN committees. This can be very time-consuming, as (under non-COVID-19 conditions) the partner's representative has to be on site at meetings in order to argue the case for modifications to a standard. To get an insight into whole-committee actions, each member reports regularly to other partners.

Standardisation activities developed during project implementation

The main standardisation activities that took place over the course of the project were:

- liaison with CEN/TC 346 ‘Conservation of cultural property’, CEN/TC 465 ‘Sustainable and smart cities and communities’, ISO/TC 268 ‘Sustainable cities and communities’ and DIN;
- use and review of many existing standards;
- a new CWA (City Resilience Development – Framework and guidance for implementation with a specific focus on historic areas) being developed, which specifies a process for cities and communities to build resilience to natural hazards and climate change, focusing on historic areas;
- the involvement of ARCH partners in formal standardisation processes at national and international levels, allowing the project to influence state-of-the-art standardisation.

Project results, outcomes and impacts

Results, outcomes and impacts achieved so far include:

- developing a combined disaster risk management and climate change adaptation cycle;
- developing information management systems for georeferenced properties of historic areas and hazards;
- adapting a vulnerability assessment method for historic areas;
- building a framework for the mapping and characterisation of European initiatives and case studies, and publishing existing initiatives and case studies in a report;
- issuing a series of state-of-the-art reports of concepts, approaches, standard and technologies on topics crucial to the project (the current state of conservation practices and concepts of disaster risk management);
- compiling four city baseline reports.

The decision support system for risk analysis, the inventory of financing options and the CWA are expected for May 2022. The pathway-planning and resilience self-assessment tools are expected by August 2022.

The project has added 20 stakeholders through the standardisation process and 12 additional cities through a mutual learning framework during its lifetime. Project partners conducted matchmaking meetings with each municipality to match local problems with specific solutions provided by ARCH.

There were slight delays in dissemination due to COVID-19.

Lessons learned – success factors, challenges and elements of good practice

- When writing the project proposal, consider standardisation as an option.

- Information on the standardisation process should be provided at the proposal stage. Explain to your consortium partners how the standardisation process works. Illustrate your expectations of the partners (e.g. what it means to chair a CEN TC, in terms of resources as well as necessary knowledge and skills). Give specific guidance on how a CWA is developed. Keep the scope of CWAs small, and focus on the most essential issues. Otherwise, the development will become very time-consuming, and the scope may not be manageable.

- Assign tasks that only deal with standardisation to the dissemination and exploitation WP, and allocate explicit time budgets for all partners. During this time, the project team members doing the standardisation can briefly monitor what has been done in other WPs, so they can see if there is an additional need for standardisation.

- Start by scanning standards that already exist and are potentially relevant. Repeat the search for standards at a later stage of the project to extend the use of standards.

- Identify potential solutions (e.g. products or services) at an early stage, and thus identify standardisation potential. Consider how project results can be implemented in the standardisation or exploitation and dissemination process.

- Standardisation decisions should only be made by partners who already have knowledge or experience of standardisation.

- Easy contact with TCs is needed (including better overviews of existing TCs).

- Provide non-standardisation organisations with better access to standards and help them to use standards'

Case study 32: Project no 958448 Building the digital thread for circular economy product, resource and service management (CircThread)

CORDIS: https://cordis.europa.eu/project/id/958448

Project website: https://circthread.com/

Start date: 1 June 2021

End date: 31 May 2025

Technology field: circular economy

Horizon programme line: IA: H2020-EU.3.5. – Societal challenges – Climate action, environment, resource efficiency and raw materials

Keywords: circularity; environment; cradle to cradle; extended product life cycle chain; digital thread; product catalogues; data contracting; industrial commons

Project and standardisation element in brief ('abstract')

The CircThread project aims to build a circular digital thread methodology that gives access to all product-related data (e.g. information on the components of which a product is made, its age and its cost). This enables information flow throughout and beyond the extended life cycle chain of products, their components, materials and chemicals. The enhanced information will empower product owners, repair companies, collectors and recyclers to optimise decisions on repair, reuse, remanufacturing or recycling loops. The consortium set out to develop one or more standardisable solutions and possibly a CWA, providing guidelines that support a complete product-related circular digital thread.

What the project is about

There is a need for a new approach to using products, as laid out by the case study project. Currently, product lifespans are shrinking, and the price of a new product is often lower than the cost of repairing one. Only a fraction of appliances are properly collected or recycled. The CircThread project uses already available product-related information to accelerate circularity and carbon emission reductions. Today, most product-related information is locked. In different phases of the enhanced product life cycle, it is stored by various organisations and individuals (e.g. manufacturers, consumers, repair companies, collectors and recyclers), but unified access is not possible. CircThread aims to unlock access to these data and allows information flow across the extended life cycle chain.

Appliances are therefore given a digital identity, accessed using a QR code. Manufacturer, consumer, repair company, collector and recycler information (e.g. energy costs, product age) will be linked to this digital identity. This will enable product lifespans to be extended, parts from old appliances to be reused, and consumers to choose more easily between reusing, remanufacturing and recycling products by allowing them to see what critical raw materials and chemicals have been used to create it. Consumers are thus empowered to make better buying and use decisions.

Three demonstration clusters in Spain, Italy and Slovenia will test seven circularity use cases (product tracking and tracing, product manufacturing, spare parts recovery, end of use

aspects, lifespan extension, critical raw materials and chemicals, consumer behaviour) for home appliances (e.g. washing machines and dishwashers) and home energy systems (e.g. boilers).

The project consortium consists of 31 partners, including universities, research and technology organisations, large enterprises, SMEs and an NSB, from 13 countries (Belgium, Denmark, France, Germany, Ireland, Italy, Portugal, Romania, Slovenia, Spain, Switzerland, Turkey and the United Kingdom).

History and genesis of the project, with a focus on how standards / standardisation needs were identified and conceptually tackled

Right from the beginning, it was clear to all technology partners and the NSB that many existing standards will enhance the productivity of the new information platform, and therefore have to be considered. They will also ensure information quality and secure interoperability with other technologies on the market. The number of use cases for established standards called for a designated standardisation WP. Approximately one third of partners are involved in the standardisation WP.

Standardisation activities developed during project implementation

The main standardisation activities that have taken place over the course of the project are these.

- A scan for relevant existing standards gave an overall picture of current state-of-the-art knowledge, and revealed any gaps that needed to be filled. TCs helped to gain access to the relevant standards.

- The following standards have been identified as directly linked to the project: EN 45552 to EN 45558, ISO 26000:2010, IEC 62474, ISO 14040, ISO 14044, the series ISO 14020:2016 to ISO 14025:2010 and ISO 14051:2011.

- Liaison with TCs allowed direct exchange of information.

Project results, outcomes and impacts

Results, outcomes and impacts achieved so far

The project had been running for about 6 months at the time of writing and has therefore hardly produced any tangible results yet. It is envisaged (as of November 2021) that one or more standardisation activities and workshop agreements will be developed.

Envisaged future results, outcomes and impacts

By the end of the project, consumers will be able to access information on their mobile devices about waste collection and repair options. This will include waste from electrical and electronic equipment. Better pre-selection of electrical and electronic waste will improve potential for material separation. Collectors and recyclers will give direct feedback on product optimisation to manufacturers, so evaluations of the potential yield and costs of innovative recycling technologies can be made. A further step on the way to the product as a service business model will be taken by original equipment manufacturers, and EU chemicals regulations and critical raw materials databases will be linked to the recovery and recycling process.

Lessons learned – success factors, challenges and elements of good practice

The scope of the standardisation project must be communicated clearly. All project partners should be provided with information on what effort (time and costs) is expected to be involved. Awareness of what consortium partners can add to the standardisation process, and how beneficial it is, should be raised. This applies, in particular, to the preparation of a pre-standard, such as a CWA, and to direct participation in TCs. Webinars or the wiki pages of NSBs or SDOs can provide this information.

Spotting two or three relevant TCs can optimise information flow about ongoing standardisation work in the community. The information should be used to inform the whole consortium.

In projects there may not be enough time to develop a full standard, but writing a pre-standard specification, such as a CWA, should be possible in most projects. It can be designed and published in about 10 months, and later developed further into a normal standard. A CWA helps disseminate project results and should be promoted to the consortium partners. Cooperation with an SDO or NSB keeps projects up to date with current standardisation activities and allows project input to the standardisation community.

Case study 33: Project no 830929 Cyber security network of competence centres for Europe (CyberSec4Europe)

CORDIS: https://cordis.europa.eu/project/id/830929

Project website: https://cybersec4europe.eu/

Start date: 1 February 2019

End date: 31 July 2022

Technology field: cybersecurity

Horizon programme line: RIA: H2020-EU.2.1.1. – Industrial leadership – Leadership in enabling and industrial technologies –ICT

Keywords: network competence centres; cybersecurity; competence network

Project and standardisation element in brief ('abstract')

CyberSec4Europe is designing, testing and demonstrating potential governance structures for a future European cybersecurity competence network to be organised by the European Cybersecurity Industrial, Technology and Research Competence Centre in Bucharest, which is to work with a network of national coordination centres designated by Member States. As a research project, CyberSec4Europe is working towards harmonising the journey from the development of software components that fit the requirements identified by a set of short- and long-term roadmaps, leading to a series of subsequent recommendations. These are tied to the project's real-world demonstration use cases, which address cybersecurity challenges within the vertical sectors of digital infrastructure, finance, government and smart cities, healthcare, and transport.

The consortium set out to reflect on standardisation strategies in cybersecurity and to develop or change several corresponding standards as appropriate.

What the project is about

The CyberSec4Europe project is a response to an EU call on cybersecurity. The EU is aiming to improve its position in the field of cybersecurity. To this end, four complementary projects from different consortia were approved, and a new cybersecurity centre is being established in Bucharest.

The project is divided into 10 WPs:

- WP1 (Project management and coordination) is not focused on specific content, but supports the action of the other WPs;
- in WP2 (Governance design and pilot), the governance model of the future of a cybersecurity competence network with the European Cybersecurity Research and Competence Centre is being developed;
- WP3 (Blueprint design and common research) describes further research, development and innovation in the field of cybersecurity, with a focus on cybersecurity in critical sectors (e.g. energy, health and finance);

- the objective of WP4 (Research and development roadmap) is to display existing capacity in the field within Europe and solutions for real-life cybersecurity problems;
- in WP5 (Demonstration use cases), particular problem areas are used as case studies for application (e.g. medical data exchange);
- WP 6 (Cybersecurity skills and capability building) builds the training framework to support continuous and lifelong learning;
- in WP7, open tools and infrastructure for certification and validation are developed;
- members of WP8 (Standardisation) keep in contact with SDOs and NSBs, and look after the linkage between project work and standards;
- WP9 (Dissemination, outreach, spreading of competence, raising awareness, exploitation) involves informing stakeholders and keeping them updated;
- WP10 (Community empowerment and innovation fostering) shapes the close collaboration with key external institutions (e.g. European institutions and agencies or sister projects).

The project consortium consists of 43 partners, including universities, research and technology organisations, large companies, SMEs, NGOs and municipalities. SDOs and NSBs are not consortium partners. They are involved by means of liaison agreements.

The project partners come from 22 countries: Austria, Belgium, Bulgaria, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Slovakia, Slovenia, Spain, Sweden and Switzerland.

History and genesis of the project, with a focus on how standards / standardisation needs were identified and conceptually tackled

Regulations in the field of cybersecurity have a significant impact on the daily life of many European citizens and companies (e.g. the ISO/IEC 27000-series, which regulates (among other things) the exchange of data within value chains). Most technical standards do not originate in Europe. This also applies to cybersecurity standards, which are shaped globally. Today, global outreach can only be achieved through standardisation. The project therefore planned to analyse the corresponding standardisation processes. Fortunately, the relevant secretariat of ISO/IEC JTC 1/SC 27 for information security, cybersecurity and privacy protection is run by the German NSB, DIN, on behalf of ISO. In other cases, projects should act strategically and scan for relevant standardisation subjects that have open-minded SDOs responsible for them.

In the project plan, standardisation is a separate WP, on which approximately 10 of the 43 partners work. Partners working on the standardisation WP have standardisation experience. Partners outside WP8, in most cases, previously had no experience, but learned a lot about standards over time. Some team experts are experienced standardisers, some of them even conveners or project editors. Ideally, the organisation/person in charge of project management should have experience of both project management and standardisation.

The first step was to establish liaisons with two WGs of ISO/IEC JTC 1/SC 27. This took about 1.5 years. Access to TCs was, in fact, very limited for a few years, because hardly any

applications for liaisons were approved. However, this situation has improved. Working with a TC (active participation in meetings, written comments, etc.) is costly and time-consuming.

Standardisation activities developed during project implementation

The main standardisation activities that took place over the course of the project were:

- establishment of liaisons;
- contribution to several standardisation projects (ISO/IEC 23264-2, Redaction of authentic data – Part 2: Redactable signature schemes based on asymmetric mechanisms; ISO/IEC 4922-1, Secure multiparty computation – Part 1: General; and ISO/IEC 4922-2, Secure multiparty computation – Part 2: Mechanisms based on secret sharing);
- inputs to a new work item (on zero-knowledge proofs).

Project results, outcomes and impacts

Results, outcomes and impacts achieved so far

The project is on schedule. The following results have been achieved so far.

- A matrix of standards and use cases has been published. The project has developed a detailed project standard matrix showing which standards match a particular use case. Many stakeholders love to use this matrix, and growing demand could be recognised. This led to the decision to publish the matrix, making it available to the public.
- Amendments to existing standards have been proposed.
- Liaisons have been established.
- Standards have been developed/revised and published, including:
    - ISO/IEC 23264-1:2021 (Information security – Redaction of authentic data),
    - ISO/IEC 27555:2021 (Information security, cybersecurity and privacy protection – Guidelines on personally identifiable information deletion),
    - ISO/IEC 27551:2021 (Information security, cybersecurity and privacy protection – Requirements for attribute-based unlikable entity authentication),
    - ISO/IEC 20008-2:2013/Amd 1:2021 (Mechanisms using a group public key) has been amended and published.
- Dissemination activities, such as workshop events, social media posts and newsletters, are taking place continuously.

Envisaged future results, outcomes and impacts

Some more standards will be published in the coming years. COVID-19 may necessitate an extension of the project.

Lessons learned – success factors, challenges and elements of good practice

- Firstly, decide on the standard you want to develop or change. Then get an overview of which standardisation organisation is in charge of which standard, and contact the corresponding SDO/NSB.

- Keep good track of the deadlines of the different standardisation bodies. You have to know the timetable of each SDO/NSB, as they have special processing times, e.g. meetings and ballots once or twice a year. Plan your standardisation project around these periods. This will help to reduce the waiting time until the next SDO/NSB activity takes place and allow an early start on influencing the standardisation organisation.

- Think across project borders. Knowledge of a previous project might be helpful or necessary. Setting ISO/IEC standards might take 3–5 years, so there could be a need to pursue a standardisation over several (follow-up) projects.

- The influence of CWAs can be seen as rather critical, as they often have major impact on the global (IT) community, compared with a (real) ISO/IEC standard.

- Utilise a wide range of project members as multipliers for influencing national SDOs in different countries.

- Check in the project's planning phase if there are any matches between the project content and standardisation.

- Best practice would be if an internal or external project coordinator or a technical project coordinator had experience in standardisation.

- Good standards are sustainable and kept up to date. Everybody should know about the standardisation process in his or her field of expertise, and each project should include an organisation or person with experience in standardisation.

Case study 34: Project no 874719 Integrated and standardised NGS workflows for personalised therapy (Instand-NGS4P)

CORDIS: https://cordis.europa.eu/project/id/874719

Project website: https://www.instandngs4p.eu

Start date: 1 January 2020

End date: 31 May 2025

Technology field: healthcare

Horizon programme line: PCP – Pre-commercial procurement: H2020-EU.3.1. – Societal challenges – Health, demographic change and well-being; H2020-EU.3.1.5. – Methods and data

Keywords: next-generation sequencing (NGS); cancer; workflow; pre-commercial procurement process

Project and standardisation element in brief ('abstract')

Medical decisions are often based on the analysis of human biological samples (e.g. blood or tissues samples) that have previously been obtained in a sampling process. During the extraction process, transportation or preparation, the sample can be compromised by different pre-analytic conditions, leading to unsuitable sample quality. Driven by patient and clinical requirements, the Instand-NGS4P project set out to create two fully integrated and standardised innovative workflows for next-generation sequencing (NGS), with a focus on patients with a routine diagnosis of common, rare, juvenile or adult cancers.

What the project is about

NGS is widely applied as a research tool, but it is used rather rarely as a diagnostic tool outside research programmes. The project's overall aim is to improve the use of NGS to help cancer patients and give doctors bedside information that supports decision-making on the best course of therapy, with data from different analytics (e.g. cancer gene testing, pharmacogenetic testing and e-medication) combined and presented clearly in one device.

This leads to the following specific objectives:

- increasing the quality of and benefit from the analytical outcome,
- creating an integrated workflow that contains pre-analytical and analytical processes as well as data analytics and decision support,
- defining new genetic variants,
- issuing reference material to control quality,
- providing benefits for patients and healthcare systems.

The project consortium consists of 19 partners, including seven medical centres; organisations participating in the European research infrastructures the Biobanking and Biomolecular Resources Research Infrastructure – European Research Infrastructure Consortium and Elixir; partners working in NGS-related EU programmes; one SME, which will act as a prospective buyer; and a standardisation organisation. Patient interests have been represented by two European patient advocacy groups. The dissemination task has been assigned to the International Prevention Research Institute. The partners come from nine countries (Belgium, Denmark, Germany, France, Italy, the Netherlands, Austria, Slovenia and Finland).

History and genesis of the project, with a focus on how standards / standardisation needs were identified and conceptually tackled

Many partners already participated in previous Horizon projects in which standards were developed (e.g. SPIDIA and SPIDIA4P). Some project partners already had established liaisons in other projects (e.g. ISO/TC 276 – Biotechnology, ISO/TC 215 – Health informatics, ISO/TC 212 – Clinical laboratory testing and *in vitro* diagnostic test systems and CEN/TC 140 – *In vitro* diagnostic systems).

Following the project call, which requested standardisation activities, a dedicated WP has been assigned to standardisation. The German standardisation organisation DIN manages the WP and is closely involved in all tasks related to standardisation. DIN has a good overview of the existing standards and helped decide if a new standard was needed. It is a lucky coincidence that DIN hosts the secretariat of CEN/TC 140, which will help transform the project's output into a standard.

The Instand-NGS4P project follows the pre-commercial procurement process, which is set up in a preparation phase and three additional phases. In the preparation phase, an open market consultation helps to identify unmet technical and medical needs. A need for four technical modules (lots), which will innovate or optimise pre-analytics, sequencing, bioinformatics and e-reporting/e-medication, has been highlighted. A split into four different lots will enable SMEs to participate in the tendering procedure. In the first phase, a call for tenders will invite companies to develop new products or solutions designed to fill the gap. At the end of each phase, an evaluation of all competitors will decide whether all requirements have been met for reaching the next phase. In phase 2, a prototype is built to test its function before implementation at the clinical consortium partners' sites to test performance in a real-world environment and usability (then phase 3).

Standardisation activities developed during project implementation

The standardisation process has been implemented throughout the whole project. At the beginning, DIN informed project members about the process of standardisation. Partners learned how to comply with the working rules of a TC and became familiar with the special language used in the field of standardisation.

In the diagnostics and therapy of patients, international standards play a significant role. Therefore, DIN together with other consortium partners analysed the standardisation landscape. Eighteen standards were found to be relevant to NGS-based diagnostics. A need-gap analysis was carried out and showed that most of the existing standards have a biological or scientific range of application and could not be used for integrated diagnostic workflows. A new work item proposal was prepared for CEN/TC 140, which was approved by May 2021. The proposal was written with the cooperation of all partners. For preparation, existing

standards were used as a basis (e.g. pre-analytics EN ISO standards or NGS-relevant standards from ISO/TC 276).

Project results, outcomes and impacts

Results, outcomes and impacts achieved so far

A new work item proposal was established at CEN/TC 140: 'In vitro diagnostic Next Generation Sequencing (NGS) workflows for the examination of human DNA/RNA'. As the project has not been running for long, more project results will appear later.

Envisaged future results, outcomes and impacts

The project will give recommendations and requirements for new or revised standards and technical specifications in the coming months and years. The project and all standards it has influenced may become sustainable if it is taken on board by ISO/TC 212.

The communication and dissemination strategy of the project aims at a broad stakeholder community. This includes measures such as training materials for healthcare workers and patients, health technology assessments, and discussions with healthcare funders and politicians.

At the end of the project, all partner organisations could implement all standardisation elements developed (which will most likely be a CEN TS and maybe also an EN ISO standard in the next step).

Lessons learned – success factors, challenges and elements of good practice

- All consortium partners need to be clear about the road ahead and set their standardisation targets early in the project. Only a combination of well-defined projects goals and outputs along with good project management will foster project results.

- A project consortium should refrain from promising to develop a standard as a deliverable, as approval is not under its control. Instead, it can state its intention to contribute to developing a new standard.

- The standardisation process follows a fixed workflow and timetable. If predefined milestones are reached at specific times, the process will continue. Otherwise, it is aborted. For that reason, the standardisation process should be monitored. The task can be carried out particularly well by involving a standardisation organisation.

- As much expertise as possible should be put into the standardisation development process.

- Any cooperation within the standardisation framework of CEN or ISO will contribute significant inputs to the standardisation activities.

- The relationship between standards and the new regulatory requirements for *in vitro* diagnostic medical devices are still not known to many stakeholders, and practical experience applying this regulation to NGS in medical diagnostics is lacking. Therefore, exploring solutions in this context will be a major impact of the pre-commercial procurement project.

- The administrative burden of a pre-commercial procurement project was underestimated. In many cases, procurement activities need legal assistance (e.g. for defining procurement criteria and writing contracts). This led to underfunding of the phase zero work, which could only be compensated for by increasing the in-kind services of project partners.

Case study 35: Project no 653569 Smart mature resilience (SMR)

CORDIS: https://cordis.europa.eu/project/id/653569

Project website: https://smr-project.eu

Start date: 1 June 2015

End date: 30 June 2018

Technology field: risk management

Horizon programme line: RIA: H2020-EU.3.7. – Secure societies – Protecting freedom and security of Europe and its citizens

Keywords: smart mature resilience; SMR; city; resilience; framework; disaster; hazard

Project and standardisation element in brief ('abstract')

For this case study, an interview appointment could not be made. However, as this project was extensively discussed in an academic paper (Lindner et al., 2021a), we combined the results and inputs from the European Commission survey and the official project documentation with the analysis from the paper.

The Smart mature resilience (SMR) project aimed to 'develop a European Resilience Management Guideline (ERMG) for building local resilience' (Lindner et al., 2021a) and thereby support city decision-makers in developing and implementing resilience measures for their cities. Three pilot projects were therefore set up in the cities of Glasgow, Kristiansand and Donostia-San Sebastian, which jointly developed and tested the project tools in a co-creation process. The European Resilience Management Guideline defines five strategic resilience-building tools. The whole process can be described as a journey with iterative steps, on which cities and municipalities have different starting points and position themselves at various stages of resilience maturity. A network of experts and public authorities of key resilient cities across Europe supports functional units of a growing and fortified European Resilience Backbone. The units support one another in overcoming the challenges arising from upcoming risks. The consortium set out to develop new CWAs.

What the project is about

European cities face increasing frequency and intensity of hazards and disasters, exacerbated by climate change and social dynamics (e.g. demographic change and an ageing population). As Europe's cities continue to grow, there is an urgent need for new approaches to enhance cities' capacity to resist, absorb, accommodate and recover from the potentially critical effects of hazards. The European Resilience Management Guideline provides cities and local governments with guidance on assessing and strengthening their local resilience. This is achieved by setting measurable targets together with local stakeholders and co-creating a city resilience strategy that makes use of five tools to build local resilience and progress within the maturity stages (Lindner et al., 2021a).

- *The Resilience Maturity Model (RMM) helps cities to assess their resilience status and to identify the ideal path for the resilience building process.*

- *The Risk Systemicity Questionnaire addresses the risk assessment aspect of increasing the resilience level of cities and prioritises risk scenarios.*

- *The Resilience Information Portal (RP) supports the building of a web-based environment for facilitating awareness and engagement among key partners in resilience building.*

- *The City Resilience Dynamics Tool helps cities to explore and simulate different strategies for implementing resilience policies.*

- *The Resilience Building Policies Tool combines custom ways to view policies of the RMM with examples from case studies for policy implementation.*

The SMR project consortium consisted of 13 partners, including six European cities (Bristol, Glasgow, Kristiansand, Riga, Rome and Vejle), universities, SMEs and NSBs. The project partners came from seven countries (Denmark, Germany, Italy, Latvia, Norway, Spain and the United Kingdom).

History and genesis of the project, with a focus on how standards / standardisation needs were identified and conceptually tackled

According to the survey answers, existing standards were considered critical for conducting research activities during the project (e.g. for agreeing on terminology or methodology), and standards helped to ensure the success of the project's exploitation and market strategy. The consortium members therefore strongly advocated incorporating standardisation activities into the project. Tasks related to standardisation were centralised in a dedicated WP. The NSB managed this WP. DIN became a consortium partner based on some of the consortium members' previous experience with DIN. It scanned for existing standards and managed the development of the CWAs. The NSB was highly involved in all standardisation tasks for the project.

Standardisation activities developed during project implementation

The project set out firstly, with respect to standardisation, to assess existing standards and thereby gather requirements for the design of the project tools. This was done using a search in the Perinorm database and by screening the websites of relevant TCs. Possibly relevant standards identified that way were evaluated further by SMR project partners using a predefined set of criteria. Out of an initial 276 standards, 64 were eventually considered relevant.

In a second step, (further) standardisation potential was assessed. To assess needs (the demand side), a questionnaire was developed, filled out and elaborated on in workshops. The result was that (Lindner et al., 2021a):

> *in total, 44 people from 28 organizations and 11 countries attended, including all project partners, as well as additional relevant stakeholders, such as other FP [framework programme] projects, cities (i.e., Prague, Udine, and Thessaloniki), consultants, and standardization experts. A total of four main needs were identified: (1) to network with other cities facing a similar variety of risks; (2) to have a common terminology for a shared understanding on city resilience; (3) to simplify cross-sectoral cooperation and integrate all relevant stakeholders of a city; and (4) to have one set of resilience tools, including good*

practices and clear resilience action plans, and a description of how to best use them.

The third and final step consisted in an assessment of the tools (to be) developed on the supply side. A set of five assessment criteria was defined: necessity; transferability; feasibility; complementation of existing standardisation landscape; and need for further inputs. Necessity was assessed subjectively on a five-point Likert scale; the other criteria were answered with 'agree' / 'don't agree'.

Project results, outcomes and impacts

Results, outcomes and impacts achieved so far

According to the three sources of evidence, the following results were achieved, among others.

- Three CWAs on ISO 37123 were developed to complement existing ISO standards or initiate new standards. The SMR tools will be considered in current standardisation processes (CWA City resilience development on operational guidance; CWA City resilience development – Maturity model; CWA City resilience development – Information portal).

- The SMR project consortium co-created the abovementioned set of five tools to help EU cities achieve resilience.

- An additional pilot implementation and final test of the European Resilience Management Guideline were conducted.

- A backbone of resilient European cities was constituted.

- Dissemination and exploitation of results were undertaken through promotion, networking, presentations and exhibitions to an audience of cities, local governments and public sector practitioners.

- Standardisation activities have been launched in which additional cities, which were not part of the consortium, and representatives from concurrent research projects have taken part.

Envisaged future results, outcomes and impacts

The consortium is pursuing its work. Its next objective is to include the SMR tools in current standardisation processes and transform the CWAs into national standards. The five tools will be commercialised, targeting users in Europe and beyond.

It is a major advantage for innovation if standards development starts early. The dissemination of best practice examples helps set up projects for success. Bundling projects enables them to learn from each other.

In the academic paper on the project, Lindner et al. (2021a) conclude:

> *We believe that currently less known dissemination and exploitation tools such as standardization will take a more prominent role in future projects to increase the impact*

of their results and to address the needs of end-users such as cities. Especially due to the increasing number of challenges cities and society are facing, the high impact of project results is expected to address these issues. Therefore, the projects funded by the FPs will particularly need to consider standards and standardization as an integral part and an essential element regarding the dissemination and exploitation of their results.

Case study 36: Project no 820776 Intelligent data-driven pipeline for the manufacturing of certified metal parts through direct energy deposition processes (Integradde)

CORDIS: https://cordis.europa.eu/project/id/820776

Project website: http://www.integraddeproject.eu/

Technology field: AM

Start date: 1 October 2018

End date: 31 March 2023

Horizon programme line: H2020-EU.2.1.5. – Industrial leadership – Leadership in enabling and industrial technologies – Advanced manufacturing and processing; H2020-EU.2.1.5.1. – Technologies for factories of the future

Keywords: safety; robotics; collaborative robots

Project and standardisation element in brief ('abstract')

The project operates in AM – more specifically, in the field of laser metal deposition. This technology needs validation, and the interoperability of different parts in the production process must be ensured under real-world conditions. Hence, standardisation is of considerable value. The case study shows that ample resources need to be planned for standardisation, and training needs to be offered to project partners that are not well versed in standards and standardisation. Two issues stand out as barriers: firstly, the different nature and timelines of processes in standardisation from those of research; secondly, the seemingly inherent tension between IP protection and the need to be open for standardisation purposes.

What the project is about

The aim of the Integradde project is 'to develop a novel end-to-end solution capable of demonstrating the potential of Directed Energy Deposition processes for the manufacturing of certified large metal components in strategic metalworking sectors' (http://www.integraddeproject.eu/project). This manufacturing technology must be validated in realistic scenarios (e.g. in relation to issues such as the positioning system). The use of standards/standardisation seeks to help increase quality and reliability in the specific AM process.

History and genesis of the project, with a focus on how standards / standardisation needs were identified and conceptually tackled

The call for proposals mentioned certification and standards, which drove the project to establish standardisation as a dedicated task from the very start (as part of the WP on dissemination and exploitation). Some of the project partners had a certain level of experience in standardisation from previous projects, and liaison with relevant TCs. However, overall knowledge of standardisation was not highly advanced. DIN was therefore involved in the project as an SDO to provide guidance and to link with TC 261 on AM. DIN was also responsible for creating a standards landscape to understand what standards exists and where the gaps to be filled are. In the proposal, all questions related to standardisation were

answered, but some room was left open in defining the standardisation tasks because the results of the project could not be precisely foreseen.

The advice given by the project team for preparing the proposal is to plan in resources for the standardisation work (e.g. for participating in and contributing to meetings). The interview partners stated that 'for researchers with little exposure to standardisation, it may be difficult to understand what is going on; here, it is important to listen to SDOs like DIN'. Furthermore, if a researcher does not deal with standardisation, he or she may not actively look for training in it. Learning in practice is hence often in the form of learning on the job while carrying out projects. Finally, understanding standardisation also entails understanding the stakeholder ecosystem involved.

Standards and standardisation during implementation of the project

During implementation of the project, liaisons have been established with three WGs of TC 261. The project members are allowed to contribute to the WG meetings and to participate in joint WGs. Interoperability has also played an important part (e.g. interoperability with different software tools, pilot lines and industrial components). Apart from liaising with TC 261, DIN has also been asked to create links with ongoing initiatives regarding design and data exchange. DIN has also carried out standardisation training for the project participants.

During implementation, the consortium has achieved interoperability by defining data formats. The project has been noticed by industry, and a big industry player has been in touch about it directly. This did not go any further, however.

One particular problem area is IP protection. One the one hand, standardisation requires open approaches; on the other, there is a need for protection. In this case, it is not so much about patents, but about (copyright) protection for software, and possibly trade secrets.

Two areas for developing standardisation activities are being explored where there are gaps in standards.

- The first area is related to digital technologies: two workshops are to be organised to discuss what a standard for them should include. If there are enough resources, a proposal for a standard will be created, but this requires commitment from at least one project partner beyond the running time of the project. Alternatively, a CWA could be sought as a basis for new standard (all to be discussed with TC 261).

- The second area is laser cladding, for which there is currently no standard to define the quality of a finished part regarding porosity. Information regarding content for a proposal has been collected, but it may be that there are not enough resources to develop a CWA.

Project results, outcomes and impacts

So far, the project has yet to achieve standardisation outputs such as CWAs. On a positive note, the activities have led to new contacts being formed that will be beneficial for any future standardisation and project activities. Hence, these liaisons can be considered a good output, even if there is a long way to go towards a standard. Accordingly, there is desire among project participants to have the opportunity to prolong the project with Horizon funding to account for the differences in timelines between standardisation processes and funded

research, and to allow enough resources for standardisation activities, as ideas abound, but resources for implementation are scarce.

Case study 37: Project no 779966 Being safe around collaborative and versatile robots in shared spaces (COVR)

CORDIS: https://cordis.europa.eu/project/id/779966/de

Project website: https://www.safearoundrobots.com/home

Technology field: collaborative robots

Start date: 1 January 2018

End date: 31 December 2021

Horizon programme line: H2020-EU.2.1.1. – Industrial leadership – Leadership in enabling and industrial technologies – ICT

Keywords: safety; robotics; collaborative robots

Project and standardisation element in brief ('abstract')

The project aimed to establish safety protocols to measure the safety of 'cobots' (i.e. robots that interact with humans in a shared space). The case study evidence suggests that standardisation is a complex and often underestimated task, involving many meetings, negotiations and interactions. To make an impact in the standardisation world, publishing through SDOs in the form of CWAs or publicly available specifications (PASs) may be preferable to publishing in academic and practitioner journals, and holds the additional benefit of creating/enlarging networks. A possible impediment to standardisation may be the perception in the standards world that inputs from EU-funded projects are overly theoretical and not in touch with the industrial reality, which may be one factor explaining why comparably few academic inputs are taken up in standardisation activities in the field. Involving people who have standardisation experience, and in particular involving SDOs as project partners, has proven to be of great help.

What the project is about

The project was 4 years in duration and aimed to validate the safety of cobots. The question behind the project was how to test the safety of cobots, rather than estimate it. Existing standards and directives for example, required that forces on a human torso should not exceed a certain threshold. However, what was missing was how to do the testing and the related safety protocol. This translated into a need for step-by-step guides on how to validate the safety of a cobot.

History and genesis of the project, with a focus on how standards / standardisation needs were identified and conceptually tackled

Standards and standardisation activities naturally played an important role in this project, which means that it was of great help that preparation of the proposal was supported by four project members who were members of relevant TCs, one of them active in the ISO/TC 299 robotics group. According to the interview partner, 'this is quite central in these types of projects'.

In the proposal, it was stated that the project would contribute to standardisation activities in the field. It must be understood, however, that the heart of the project was not standards, but

protocols. This subtle difference had several consequences. Firstly, even in the proposal, given the strict processes in standardisation, it is not sufficient to just say that the project results 'will feed into standardisation processes' (interview partner). The question of what information is going to be fed to whom, and how, needs to be tackled in a very clear way, otherwise 'feeding into standardisation processes' will not work.

A second issue to be aware of when preparing the proposal is that standardisation/TC members might be reluctant to cater for academics, as there is an 'instant suspicion' (interview partner) that academic inputs are going to neglect the value of practicality and will advocate over-regulation. Remembering that standardisation is carried out by industry, this is probably one reason why our interview partner may feel that little truly academic research seems to feed into standardisation activities in this field.

Standards and standardisation during implementation of the project

During the project's implementation, putting life into the aspect of 'feeding into standardisation processes' proved a challenge. It turned out that that standardisation is a tricky landscape, so it was good to have people on board who had standardisation experience and public profiles in the relevant community. Still, it proved beneficial to also involve the national SDO in the project – something that was not planned at the proposal stage. However, when taken on board, the SDO's involvement proved to be highly beneficial for issues such as getting the processes explained in detail, making connections to TCs and ensuring that the right forms were filled out in the correct way.

Apart from that, the following success factors during implementation were noted:

- a hands-on, low-level practical attitude, and knowledge of know-how transfer;
- delivery in good time, given the complexity and strict nature of standardisation processes;
- being well prepared for the highly political and bureaucratic nature of standardisation, which had come as a surprise to the study team (with a lot of talking and many meetings involved) – it is important to remain resilient in such an environment.

Finally, to have real impact, it is not sufficient to have good publications in scholarly or practitioner journals, and it is necessary to publish through the standardisation bodies. To that end, the project sought several avenues, including an ISO/PAS on how to measure collision forces (at first, an annex to an existing standard was considered, but this proved too complex, so a PAS was chosen instead), and a CWA on how to take measurements (described at a more general level), which also tackles issues of differentiation between mobile cobots and industrial cobots (the differentiation in other standards not being really necessary in this context), as well as the safety skills of cobots (i.e. their ability not to hit a person too hard).

Project results, outcomes and impacts

The CWA was developed for December 2021, while the PAS is scheduled to be ready in the first quarter of 2022. In general, different types of standards publications can be considered output/outcome indicators. Another good indicator is the formation of a WG, which the project succeeded in initiating (TC 299 WG 8). Finally, the interview partner also considered that

publishing through the SDOs is beneficial, because ‘one gets in contact with a lot of people around the world that can give feedback’.

Case study 38: Project no 814494 Intelligent open test bed for materials tribological characterisation services (i-Tribomat)

CORDIS: https://cordis.europa.eu/project/id/814494/de

Project website: https://www.i-tribomat.eu/

Technology field: material sciences

Start date: 1 January 2019

End date: 31 December 2022

Horizon programme line: H2020-EU.2.1.5. – Industrial leadership – Leadership in enabling and industrial technologies – Advanced manufacturing and processing; H2020-EU.2.1.3. – Industrial leadership – Leadership in enabling and industrial technologies – Advanced materials; H2020-EU.2.1.2. – Industrial leadership – Leadership in enabling and industrial technologies – Nanotechnologies

Keywords: material sciences; advanced manufacturing; testing; additive manufacturing

Project and standardisation element in brief ('abstract')

The project aims to contribute to the goal of establishing a European tribology centre, bundling the know-how of several tribology competence centres in EU Member States. In terms of standardisation, there is a need to standardise and harmonise testing procedures in specific ways that are independent of the tribometers (measurement devices used in this technology field) of particular manufacturers. This case study discusses, among other topics, the interaction of trade secrets with standards as a challenge to be tackled.

What the project is about

Tribology is concerned with the interaction of surfaces in motion, studying issues such as friction, lubrication and wear. The project aims to contribute to the goal of establishing a European tribology centre, bundling the know-how of several tribology competence centres in EU Member States. More specifically, the project aims to 'provide the world's first Open Innovation Test Bed dedicated to validating and up-scaling new materials, thereby enabling intelligent Tribological Materials Characterisation and fostering industrial innovation in the European manufacturing industry' (https://www.i-tribomat.eu/). Hence, the goal is to offer research services to characterise materials and to provide tribology services, thereby reducing costs and time to market when upscaling materials.

Standardisation in tribology is, in part, an established concept, but the standards available are very general and unspecific, and, where they are specific, highly dependent on specific tribometers of specific manufacturers. This situation makes it difficult to test in harmonised ways across different labs using different tribometers. There is hence a need for standardisation and protocols in the testing methods, irrespective of the tribometers used. Furthermore, there is also a need for a database of common terminologies. The project aims to tackle both aspects.

History and genesis of the project, with a focus on how standards / standardisation needs were identified and conceptually tackled

Due to the composition of the consortium – the German Federal Institute for Materials Research and Testing (BAM) is a project partner, for example – the team already had a good level of experience with standardisation. An employee of BAM who was also on a materials-related TC co-authored the proposal for the project. Therefore, awareness of the importance of standards and know-how regarding standardisation processes has been present in the project from the outset.

A very peculiar aspect of the proposal writing was avoiding defining the standardisation activities too precisely. In fact, no standard – except ISO 9001 for quality assurance – was even mentioned in the proposal. The reason for this is that the project also needed to underpin the formation of a commercial spin-off company.

As the tribology know-how developed was, in large parts, process know-how, which is difficult to copy unless key employees change their jobs or industrial espionage takes place, the appropriate IP strategy relied heavily on trade secrets. This kind of IP strategy is, however, at odds with standardisation, which requires publication. The project therefore had to manage a thin line between the management of the IP and the standardisation processes, in order to ensure provision of meaningful input for standardisation, while not divulging secret and commercially valuable information that can be copied by competitors of the start-up.

Generally, however, standardisation aspects that do not touch upon trade secrets commercialised by a start-up should be tackled as precisely and as early as possible, because standardisation work needs time (see also next section).

Standards and standardisation during implementation of the project

During the implementation of the project, the TC member who worked on the proposal was no longer available, so there has been no personal overlap between TCs and the project team. Still, because partners such as BAM have been active in standardisation, standardisation expertise could easily be found in the consortium's organisations. In the project team, there is also expertise in the drafting of CWAs, which was obtained during this project.

As the project started out with relatively imprecisely defined standardisation activities, it has been paramount to get up to speed with standardisation early in the project. The reason for this is that standardisation activities take time, because 'one needs to network, build contacts' (interview partner). It is advised that, if a project does not have a person working on standards directly, it would be good to seek one because 'personal contacts can really help a lot in standardisation work' (interview partner). Furthermore, industry should be interested in standardisation. The project has thus found that it is good to involve industry partners as consortium partners in the proposal, and to have them provide feedback on the standardisation activities.

What makes standardisation difficult is the need to reach consensus (which, on the other hand, if achieved, is also a benefit). To reach consensus, a lot of discussion is necessary, so 'researchers must be aware that standardisation work is discussion work' (interview partner). To be able to successfully discuss and negotiate on behalf of the consortium, it is necessary to create a common line of thinking within it. At operational level, this means, for example, planning for reconciliation meetings and avoiding situations in which consortium partners

contradict each other in standardisation WGs and TCs. The earlier such issues can be raised and tackled – e.g. during proposal writing – the better.

Project results, outcomes and impacts

The project has highlighted the potential (e.g. in relation to measurement standards) for objective parameters to be used as KPIs. This relates, for example, to new ways of measuring that reduce measurement errors (with the extent of reduction of the error being a KPI). The proof can be provided through interlaboratory (round robin) tests. Because of the abovementioned issue of trade secrets, the project does not have dedicated KPIs for outputs such as CWAs or other contributions to standardisation. In general, however, KPIs related to standardisation could be:

- how many (of the relevant) standardisation committees / WGs have had a project partner as a member;
- how many interlaboratory / round robin tests have been performed;
- how many industry partners use the new measurement techniques.

Sustainability of project results after the lifetime of the project should be ensured through the start-up that commercialises the developed technologies.

Final and general advice by the interview partner for other researchers is not to underestimate the complexity of standards and standardisation.

Case study 39: Project no 953219 European activity for standardization of industrial residual stress characterisation (Easi-Stress)

CORDIS: https://cordis.europa.eu/project/id/953219/de

Project website: https://easi-stress.eu/about/consortium/index.php.en

Technology field: material sciences

Start date: 1 January 2021

End date: 31 December 2023

Horizon programme line: H2020-EU.2.1.5. – Industrial leadership – Leadership in enabling and industrial technologies – Advanced manufacturing and processing; H2020-EU.2.1.3. – Industrial leadership – Leadership in enabling and industrial technologies – Advanced materials; H2020-EU.2.1.2. – Industrial leadership – Leadership in enabling and industrial technologies – Nanotechnologies

Keywords: material sciences; advanced manufacturing; testing

Project and standardisation element in brief ('abstract')

The Easi-Stress project deals with a technology to assess residual stress in metals non-destructively. To this end, standards are needed for how to perform the testing. The absence of such standards in the past is seen as the major reason why the technology has not been yet taken up by industry. The project aims to develop a technical specification with CEN-CENELEC. Success factors for the standardisation activities are:

- stakeholder engagement that ensures industry support;
- the involvement of SDOs that help with standardisation questions and provide the relevant know-how within the project consortium;
- effective handling of challenges related to managing open explorative research processes and stricter standardisation processes;
- close links to TCs.

What the project is about

The project deals with a technology to assess residual stress non-destructively using synchrotron radiation, which is recognised in the academic world and has been demonstrated in a number of pilot projects, but has not been picked up by industry yet. Presumably, this is because of the lack of a standard for how to do measurements using this technique. Hence, the Easi-Stress project seeks to develop, among other things, 'European-wide characterisation standards, protocols and data exchange procedures to facilitate the industrial use of the characterisation tools, e.g. through traceability and comparability … strengthen European industrial uptake of the characterization tools through open access to data and protocols, development of a test bed service and collaboration/synergy/standardization activities' (see https://www.easi-stress.eu/).

History and genesis of the project, with a focus on how standards / standardisation needs were identified and conceptually tackled

Synchrotron X-ray and neutron diffraction-based residual stress characterisation tools have technological properties that would make them superior to other stress assessment methods, and according to our interview partner this has been known in academia for 20 years and has been demonstrated in several pilot projects. According to the interview partner, however, 'it remained a mystery as to why the technology was not picked up by industry'. The research organisations that also do business with materials testing as a service for industry (i.e. research and technology organisations) identified the lack of proper standards as one key impediment to uptake of the technology some 3 years ago.

'There has been probably lack of trust in a technology which may be, from the current industry's point of view, difficult to understand. Hence, not many people in industry will put their jobs on the line for a new technology' (interview partner).

Standards and standardisation were lacking for good testing protocols – clear indications of when to use the technology and when not to, reference samples, measurement protocols, etc. Against this backdrop, Easi-Stress was designed to overcome this gap and help commercialise the technology as a new research service.

Interestingly, an existing form of official standard for the technology has been identified. However, this standard has not been used, presumably because it was not supported by industry. According to our interview partner, 'standardisation is not an end in itself, but a means to an end; if there is no good industry support, standardisation should not be sought'.

While the organisations involved in the proposal writing had some experience with standards and standardisation activities – mostly by applying existing standards – the process of standardisation and working towards new standards was, to some extent, new to the researchers involved. This was one reason why SDOs were involved in the project consortium (it was also recommended in the call for proposals), and two research and technology organisations were chosen that had experience with standards. It became evident that standardisation and H2020 exemplified two different mindsets, with a particular challenge in synchronising the different timelines. According to our interview partner, 'on one hand, you had the more explorative H2020 research, and on the other hand, the SDO told us very specifically that within 52 weeks we have to do exactly this and that (i.e. account for a strict standardisation process) – basically, we had to deal with a standardisation process that is not easy to sync with our research timeline.'

Overall, the world of standardisation was new to the researchers. The goal has been, within the time frame of the project, to go not for a real standard, but for a technical specification. A benefit of this approach is also the ability to keep the technology and its development processes more under the control of the consortium.

Standards and standardisation during implementation of the project

The first major steps in the projects have been in relation to developing a new work item proposal with CEN-CENELEC, which is also a first step towards the technical specification. To achieve this, there must be a vote at which at least five TC members and 55 % of the countries present vote in favour of establishing a WG (for voting rules, see https://boss.cen.eu/startingnewwork/pages/propnewwork/pages/). This kind of voting procedure means that stakeholder engagement is necessary, ensuring that there are sufficient votes for an idea.

The interview partner stated that 'this was new to all partners of the project, and we understood that we really needed to go out and engage with individuals, organisations, [and] organise communication'. Engagement is taken even further with a section on the project's website that allows interested industry partners to register. A string of webinars has been held to inform industry and ignite interest from it, with the aim of building a community.

There is still an element of uncertainty regarding the voting, and contingency planning is in place in case the votes do not turn out as desired (the plan B is a draft technical specification, rather than an official technical specification itself). The preference is clearly to get to the level of an official technical specification, however, as that is an official document and hence may be more compelling to industry than a simple technical report created within the H2020 project.

Involvement of SDOs in the consortium ensured that all of this was communicated clearly and early to the project partners, as (according to our interview partner) 'the SDOs have the necessary process know-how'. Still, communicating standardisation-related issues and helping project partners, who may be less well versed in standardisation, understand and support it is a task the project leader must be prepared to take on. Clearly defining standard-specific tasks in the WPs, underpinned by budget, helps with this.

Project results, outcomes and impacts

At the time of writing the case study, it is too early to discuss realised standardisation-related results, outputs and impacts. However, the hope is that, when the technical specification is ready as the main outcome of the project, industry will become a client of the research and technology organisations that have been developing the technology. Sustainability of the project results is therefore key.

Sustainability is sought in two ways.

- The official technical specification will be downloadable from the CEN-CENELEC page for a long time.

- Through building a community throughout the project, the hope is to reach a critical mass at which it remains somehow self-sustained. Against this backdrop, it is noteworthy that standardisation can help networks that far exceed the reach of Horizon project consortium networks, as evidenced by a South African company that recently got in touch with the research project.

The project benefits from its potential to provide technological improvements for numerous industries.

Case study 40: Project no 870620 European research infrastructure supporting smart grid and smart energy systems research, technology development, validation and roll out – second edition (ERIGrid 2.0)

CORDIS: https://cordis.europa.eu/project/id/870620/de

Project website: https://erigrid2.eu/

Technology field: renewable energies, smart grids

Start date: 1 April 2020

End date: 30 September 2024

Horizon programme line: H2020-EU.2.1.3. – Industrial leadership – Leadership in enabling and industrial technologies – Advanced materials; H2020-EU.2.1.2. – Industrial leadership – Leadership in enabling and industrial technologies – Nanotechnologies

Keywords: tribology; friction; lubrication; wear

Project and standardisation element in brief ('abstract')

The ERIGrid 2.0 project is concerned with the provision of RI in a pan-European context for validating, testing and simulating smart grid technologies. Standardisation needs mainly arise in two forms: the need to properly define use cases for accessing RI and, more specifically, to specify methodologies in simulations that take place partly within software, and partly using physical hardware (hardware in the loop).

Success factors for standardisation noted include:

- having a string of projects dealing with standardisation (ERIGrid 2.0 is the latest in a string of projects dating back to the sixth framework programme);
- stakeholder management;
- having participants in the projects active in relevant standardisation committees;
- adjusting to the different formal processes in standardisation;
- appropriate resourcing of standardisation activities;
- carefully planned and interconnected management of IP and standards/standardisation activities.

What the project is about

The project deals with energy infrastructure and smart grids. The major issue addressed is the integration of RES into energy grids. This poses several challenges, as RES behave differently from traditional sources (through more stochastic power generation behaviour, for example). Technology developments, controllable loads, integration with other energy sources, changing regulatory rules and market liberalisation are further issues to be catered

for in smart grids. A basic requirement to meet for the operation of smart grids is to have the different components of the grids meet clear-cut criteria for efficient, safe and reliable operation. To this end, there is a need for proper validation approaches and tools. ERIGrid 2.0 aims to provide access to a pan-European RI to enable such experimentation and validation capabilities (i.e. it offers state-of-the-art improved research services, methods and tools for researchers in the smart grid and renewable energies sector).

History and genesis of the project, with a focus on how standards / standardisation needs were identified and conceptually tackled

The project has a history that goes back to 2005 and the sixth framework programme. In the sixth framework programme, the Distributed Energy Resources Laboratories project provided the starting point for a string of projects.

The objectives (see https://cordis.europa.eu/project/id/518299) were to:

- support the sustainable integration of RES and distributed energy resources in the electricity supply by developing common requirements and quality criteria, as well as proposing test and certification procedures concerning connection, safety, operation and communication of distributed energy resource components and systems;
- strengthen the European Commission domestic market and protect European interests at international standardisation level;
- establish a durable European network of distributed energy resources laboratories that will be a world player in the field.

The project activities were continued – in line with advancements in research and technology – with the Distributed Energy Resources Research Infrastructure project in the seventh framework programme, ERIGrid (H2020) and, now, ERIGrid 2.0.

Standardisation, particularly pre-standardisation and harmonisation, has hence played a key role in this chain of projects, which has materialised in two areas:

- the rather broad definition of use cases for using the research infrastructure,
- the more specific area of hardware-in-the-loop simulations.

The first case relates, for example, to approaches for automated operation of energy grids. Researchers in this area who want to obtain access to the research infrastructure need to write short proposals of around 10 pages. However, processing these may turn out to be difficult if there is no clear understanding of what the researchers really want. Key issues need to be clarified and a common terminology used (e.g. to enable the proper definition of what a test case constitutes, or what exactly will be implemented in the lab). This needs to be harmonised across all labs in Europe participating in ERIGrid 2.0. As a result, a template was developed in which test cases could be described. This approach, very much akin to use cases in other industries, led to the development of the concept of a holistic validation approach.

The second area that has standardisation needs is real-time simulation, whereby parts of the grid are simulated in software, while other parts operate with real/physical components. This mixture of software and physical hardware (called hardware in the loop) also needs specification of methods. Relevant standardisation approaches are the subject of the P2004

project and corresponding WG at the IEE), and ERIGrid was able to deliver inputs to P2004. P2004 relates to the development of a 'recommended practice' at the IEEE (such a practice constitutes 'the lowest level of a standard' (interview partner)).

Standards and standardisation during implementation of the project

According to the interview partner, the project-related standardisation activities in ERIGrid 2.0 are 'rather research-driven and hence not yet standards'. Notwithstanding this, with key institutions in the ERIGrid consortium having been active in testing and validating power grid components for decades, standards and standardisation are 'part of the DNA [of] our activities'. Many employees are active in standardisation activities and participate in corresponding WGs and committees. In the specific case of the ERIGrid 2.0 project, there has not been direct collaboration with an SDO during implementation, but the project had some 70 support letters, some of which were from SDOs. Standardisation was defined as a dedicated task in relation to the IEEE P2004 project. During implementation and in relation to standardisation, in the experience of our interview partner, the following challenges must be tackled.

- **Timing/syncing:** Developing a standard out of a single Horizon project is not possible due to the different time frames (5–10 years for developing a standard, as opposed to 3, or in this case 4, years for a Horizon project). However, having a chain of successively funded projects can help here.

- **Different working procedures in standardisation:** Standardisation WGs and committees act in a very formal manner, and researchers need to be aware of this. It was said, for example, that 'you cannot just start working on ideas, you need to submit these first (a project authorization request, in the case of the IEEE), and then there needs to be a vote on the requests' (interview partner). Furthermore, one must note that the lower/initial levels of standardisation have the same level of formal procedures as more advanced stages of standardisation.

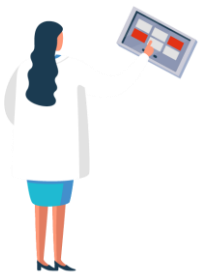
- **Stakeholder management and TC involvement:** In the light of the bullet point above, it was said in the interview that 'it helps if you have contacts with the respective working groups and committees in standardisation'. The vice chair of the P2004 group is a good colleague working at the lead organisation of the ERIGrid 2.0 project. Furthermore, the P2004 chair was involved in the ERIGrid project as part of the advisory board. The interview partner noted that the standardisation WGs are considerably larger than the project consortium. It is necessary 'to pick up the stakeholders, market [your] agenda, to catch their interest'.

- **Proper resourcing:** Engaging in standardisation and stakeholder management requires considerable time. Establishing a dedicated task for standardisation (in the case of this project, this was made part of the WP on exploitation) is therefore recommended. It is also helpful to have a dedicated task, as it provides some sort of mandatory character to the work to be done, even if the exact activities are not clear at the stage of proposal writing.

- **IP:** An important topic during implementation is IP. As the SDO (in this case, the IEEE) must be able to publish its specifications and recommendations, 'the IP situation must be carefully considered' (interview partner). This means applying for patents, where needed, and managing the standardisation process at the same time in a planned manner and interconnected with IP management activities.

Project results, outcomes and impacts

ERIGrid 2.0 has several standardisation-related outputs, including templates for test cases (uploaded to Zenodo by the European Organization for Nuclear Research) and simulation models uploaded to GitHub, contributing to P2004 at the IEEE. There is strong interaction in the sharing of outputs with the Bridge-Horizon2020 initiative of the European Commission, which 'unites Horizon 2020 Smart Grid, Energy Storage, Islands, and Digitalisation Projects to create a structured view of cross-cutting issues which are encountered in the demonstration projects and may constitute an obstacle to innovation' (https://www.h2020-bridge.eu/). This also exemplifies network effects (i.e. participation in several initiatives and projects, also with their own networking events and workshops) that provide shortcuts to interact with stakeholders outside the immediately funded ERIGrid 2.0 activities.



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The Scoping study for supporting the development of a Code of Practice for researchers on standardisation aims to identify elements of good practice for researchers dealing with standards and standardisation in the course of research projects funded by Horizon 2020. Results indicate the existence of a stable and recurring set of elements of good practice. One important result is that the more exploratory research activities and the more formal standardisation processes are different in nature and difficult to synchronise. Standardisation activities within a research project largely lead to a need to engage in wider stakeholder management. There need to be close ties between the research consortia and the technical committees that develop standards. Researchers' awareness of and know-how about standardisation processes are frequently low, and the development of recognised performance indicators to track the success of technology transfer and valorisation activities is in its infancy. Recommendations were developed for universities / public research organisations (institutional level), researchers (project level), policymakers and the wider stakeholder community, and specifically regarding the development of performance indicators.

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