MAESTRI

Total Resource and Energy Efficiency
Management System for Process Industries

Deliverable **7.5**

Pro-active standardization strategy

Date: 28/02/2017

WP7 Exploitation and Sustainability actions

T7.2 Contribution to the EU frameworks & Standardization

Dissemination Level Public

Project website: www.maestri-spire.eu

SPIRE Sustainable Process Industry through Resource and Energy Efficiency

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 680570

Author

Name: Marco
Surname: Estrela
Organisation: ISQ

Name: Rita
Surname: Soares
Organisation: ISQ

Document history

VERSION	DATE	AUTHOR	DESCRIPTION
	11.01.2017	M. Estrela (ISQ)	Document describing contents and contributions
	13.02.2017	M. Benedetti(UCAM)	Inputs to the document
	15.02.2017	E. Lezak (IZNAB)	Inputs to the document
	15.02.2017	F. Rizzo (ISMB)	Inputs to the document
0.1	27.02.2017	M. Estrela	Version for review
1.0	28.02.2017	M. Estrela	Final version

Internal revision history

REVISION	DATE	AUTHOR	ORGANISATION	DESCRIPTION
01	27.02.2017	Stanisław Plebanek	LEIP	Reviewed the document
02	27.02.2017	António Baptista	INEGI	Reviewed the document
03	27.02.2017	Maria Holgado	UCAM	Reviewed the document

Document details

FILE NAME	VERSION
D7.5_MAESTRI_ Pro-active standardization strategy_v1.0	1.0

DOCUMENT OWNER	ORGANISATION
M. Estrela	ISQ

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 680570

Table of contents

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 680570

Figures

Tables

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 680570

List of Acronyms

AFNOR - Association Française de Normalisation (French national organization for standardization)

ANSI - American National Standards Institute

BSI - British Standards Institution

CEBR - Centre for Economics and Business Research

CEN - European Committee for Standardization

CENELEC - European Committee for Electro-Technical Standardization

Codified knowledge - knowledge that can be readily articulated, codified, accessed and verbalized. It can be easily transmitted to others.

DIN - Deutsches Institut für Normung

ETSI - European Telecommunications Standards Institute

GVA – Gross Value Added

IEC - International Electrotechnical Commission

IETF - Internet Engineering Task Force

IIRA – Industrial Internet Reference Architecture

IS – Industrial Symbiosis

ISO - International Organization for Standardization

ITU - International Telecommunication Union

SDO – Standards Development Organisation

Tacit knowledge - is the kind of knowledge that is difficult to transfer to another person by means of writing it down or verbalizing it.

WTO – World Trade Organization

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 680570

1 Executive Summary

This deliverable gives an overview of how standards and research interact and the role of standardization in research projects. The contribution of research projects to standardization and the contribution of standards to the economy are also briefly addressed.

Next, the process of developing standards is explained and the standardization bodies responsible for doing that are described. Some CEN committees relevant to MAESTRI were identified.

A state-of-the-art in standardization initiatives relevant to MAESTRI was performed.

This document presents MAESTRI's strategy for engaging standardization bodies. This involves continuous monitoring of standards relevant to MAESTRI.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 680570

2 Introduction

2.1 The correlation of standardization and research

2.1.1 General aspects

Standardization acts in a well-defined framework. Next to internal rules for organizing work, this framework is influenced by requirements and drivers of standardization:

- standards are voluntary by nature to be implemented or not;
- proposals may come from any individual, group, association or any stakeholder. Standardization in Europe is considered to be industry driven, thus addressing industry's needs, not without consulting and including all interested stakeholders in the development process of a standard;
- others dimension are added by standards being referenced in legislation and being a backbone of the overall quality infrastructure in Europe. The framework is constantly adapted to the needs of industry, needs of users, needs of politics.

When new technologies or new research results and knowledge are available, they are integrated into standardization within the existing framework, which is characterized by a consecutive process that has two parallel strands (see Figure 1).

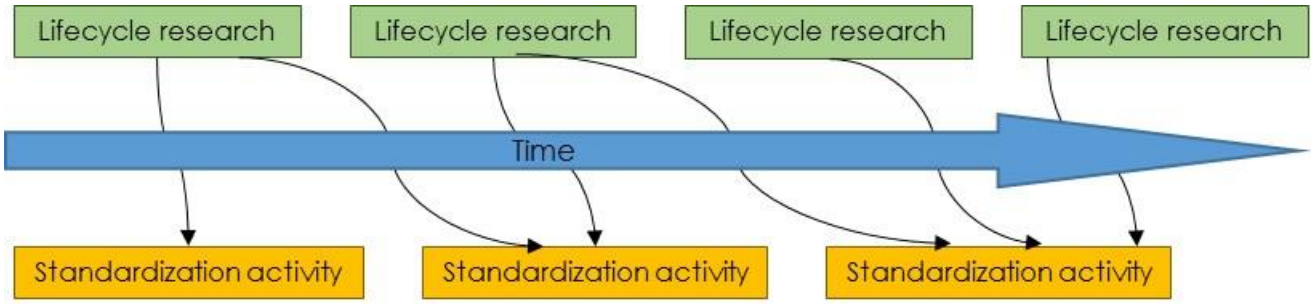


Figure 1: Lifecycles of Research and Standardization Activities Lifecycle

Research in this type of process is thus lagging "behind" standardization, meaning that its results are being transferred mostly after a research project has been finished, rarely during its lifetime. If specific research has been linked to specific standardization, which is often called pre-normative research, this implies even the consecutiveness in the process of transfer.

2.1.2 The role of standardization in research projects

The function of standardization in the research process has been studied and documented. The approach of Blind and Jungmittag[1] breaks down "research" into the life cycle of research and relates the different types of standards to the phases of research that it can significantly support (see Figure 2).

[1] K. Blind, A Jungmittag, The impact of patents and standards on the macroeconomic growth: a panel approach covering four countries and 12 sectors; J. Prod. Anal. 29 (1) (2008) 51-60.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 680570

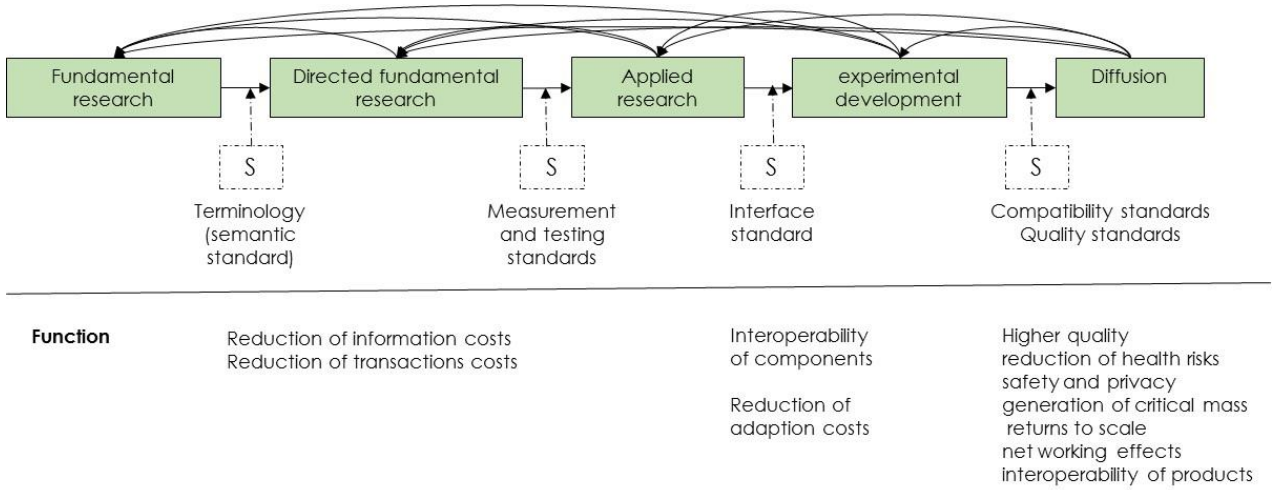


Figure 2: Standards in the research and innovation process

Standards can impact research by providing knowledge already verified by a group of relevant stakeholders, i. e. experts in the field. Standards can codify, define and describe recognized methodologies, processes, terminology, etc. assuring that these present the state-of-the-art. This can prevent research from reinventing the wheel.

Thus, the identification and use of existing standards can contribute to a research project.

On the other hand, standardization can enable fast and easier market exploitation of research results, as standards available in the area usually reassure users. Project outcomes can be "tested" with a wide community of stakeholders, raise their awareness of the project results and expand the original network.

On the technical side, standards enhance i.e. interoperability, comparability and compatibility with what exists, thus supporting market entrance and market penetration. Project results taken up in a standard remain available beyond the project's life-time, are regularly revised and present a format for long-term exploitation of the project results.

Last, but not least, standards contribute to increasing the intensity of competition and export potentials and powers.

Discovery and exploitation of standardization potentials therefore should be another focus of linking research and standardization. If the interrelationship of standards, markets and innovation are neglected, leadership in markets could be lost.

2.1.3 The contribution of research projects to standardization and their benefits

A study commissioned by CEN and CENELEC [2] provides a basis of evidence for understanding how European research projects can contribute to standardization activities, and how such links can help to facilitate the dissemination of innovation.

[2] The European Committee for Standardization and the European Committee for Electro-Technical Standardization

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 680570

The study[3] analysed how different research projects have included links with standardization and the benefits this brings, focusing on research projects supported by the European Union's 6th and 7th Framework Programs (FP6 and FP7).

According to the results of the study, around one third of European research projects (supported by FP6 and FP7) have either made use of standards or addressed standardization in some other way.

The study identifies a wide range of benefits for projects that contributed to standardization. For example, more than 80% of projects having proposed or developed new standards declared that standards improved dissemination of their research results. Nearly three-quarters (73%) of project coordinators who had included standards in their previous projects said that they would be willing to address standardization again in their future projects.

2.2 Contribution of standards to the economy

A new study[4] reveals the economic contribution of standards to the UK economy and businesses. Published by the Centre for Economics and Business Research (CEBR) and commissioned by BSI, the report is the most comprehensive study to date on the economic benefits of standards, looking at data for the period 1921-2013.

The research finds that standards boost UK productivity and improve performance, kick-start innovation, and support UK domestic and international trade.

The report analyses the macroeconomic and microeconomic impact of BSI's consensus based voluntary standards across the UK economy. It concludes that they are a vital part of the strength of UK industry and play a crucial and often invisible role in supporting economic growth.

The research finds that:

- standards contribute towards 28.4% of annual UK GDP growth, equivalent to £8.2 billion in 2013;
- 37.4% of UK productivity growth can be attributed to standards;
- £6.1 billion of additional UK exports per year can be attributed to standards.

Of the companies surveyed for the research:

- 84% say that using standards enhances their reputation;
- 73% say that standards allow greater control of environmental problems;

[3] The final report of the 'Study on the contribution of standardization to innovation in European-funded research projects' is available at: www.cencenelec.eu/research/SuccessStories . The summary can be found at http://www.cencenelec.eu/research/news/publications/Publications/https___nitrocloudprod.s3.amazonaws.com_(111821598)%20Connect14.pdf

[4] The Economic Contribution of Standards to the UK Economy (2015) Centre for Economics and Business Research (CEBR) commissioned by BSI

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 680570

- 89% say that standards contribute to the optimization of compliance with regulations, such as health and safety legislation;

- 50% say that standards encourage innovation through the diffusion of knowledge; and 70% say that standards contribute to improving their supply chain by improving the quality of supplier products and services.

The research also finds that investing in standards pays dividends for organizations that use them and that standards predominantly generate more benefits for companies that use them relative to the cost to implement.

Across the seven sectors analysed, the research found that standards contributed towards around £33 billion to annual turnover across all these sectors in 2013, in the UK. This translates into £6.9 billion per year in Gross Value Added (GVA) terms.

In Germany, the DIN (2011)[5] study sought to update and improve upon the initial investigation into The Economic Benefits of Standardisation (DIN, 2000)[6]. This research estimated the value of labour, capital, standards, patents and licences to output as measured by GVA. The results indicate that Standards have a significant and positive association with economic output, however, the magnitude of this relationship changed over time due to economic shocks experienced by the German economy. Taking these into account, the study shows that a 1% change in the stock of standards is positively associated with a 0.7% to 0.8% change in economic growth following German reunification.

In France, AFNOR (2009)[7] conducted a macroeconomic investigation into the impact of Standards on economic growth as measured by Total Factor Productivity (TFP). Their results indicate that, on average since 1950, the impact of standards on economic growth has been significant and positive such that a 1% change in the stock of Standards is positively associated with a 0.12% change in total factor productivity.

[5] DIN. (2011). The Economic Benefits of Standardisation: An update of the study carried out by DIN in 2000, DIN German Institute of Standardisation, Berlin.
[6] DIN. (2000). The Economic Benefits of Standardisation. DIN German Institute of Standardisation, Berlin.
[7] AFNOR. (2009). The Economic Impact of Standardization – Technological Change, Standards and Long-Term Growth in France. AFNOR, Paris.

MAESTRI
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 680570

3 How European Standards are produced

3.1 Introduction

A standard is a document that provides rules, guidelines or characteristics for activities or their results, for common and repeated use. Standards are created by bringing together all interested parties including manufacturers, users, consumers and regulators of a particular material, product, process or service. Everyone benefits from standardization through increased product safety and quality as well as lower transaction costs and prices.

Each European Standard is identified by a unique reference code which contains the letters 'EN'. A European Standard is a standard that has been adopted by one of the three recognized European Standardization Organizations (ESOs): CEN, CENELEC or ETSI. It is produced by all interested parties through a transparent, open and consensus based process.

European Standards are a key component of the Single European Market. Although rather technical and mostly unknown to the public and media, they represent one of the most important issues for businesses. Often perceived as "boring" and not particularly relevant to some organizations, they are actually crucial in facilitating trade and hence have high visibility among manufacturers inside and outside Europe. Standards provide individuals, businesses and all kinds or organizations with a common basis for mutual understanding. A standard represents a model specification, a technical solution against which a market can trade. It codifies best practice and is usually state of the art.

In essence, European Standards relate to products, services or systems. Today, however, standards are no longer created only for technical reasons but have also become enablers for greater social inclusiveness and engagement with technology, as well as convergence and interoperability within growing markets across industries.

CEN, the European Committee for Standardization, is an association that brings together the National Standardization Bodies of 33 European countries.

CEN is one of three European Standardization Organizations (together with CENELEC and ETSI) that have been officially recognized by the European Union and by the European Free Trade Association (EFTA) as being responsible for developing and defining voluntary standards at European level.

CEN provides a platform for the development of European Standards and other technical documents in relation to various kinds of products, materials, services and processes.

CEN supports standardization activities in relation to a wide range of fields and sectors including: air and space, chemicals, construction, consumer products, defence and security, energy, the environment, food and feed, health and safety, healthcare, ICT, machinery, materials, pressure equipment, services, smart living, transport and packaging.

3.2 EU Member State Standardisation Organisations

CEN's National Members are the National Standardization Bodies (NSBs) of the 28 European Union countries, the Former Yugoslav Republic of Macedonia, Serbia and Turkey plus three

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 680570

countries of the European Free Trade Association (Iceland, Norway and Switzerland). There is one member per country.

A National Standardization Body is the one stop shop for all stakeholders and is the main focal point of access to the concerted system, which comprises regional (European) and international (ISO) standardization. It is the responsibility of the CEN National Members to implement European Standards as National Standards. The National Standardization Bodies distribute and sell the implemented European Standard and have to withdraw any conflicting national standards.

Table 1 - National Standardization Bodies

Acronym	Country	Organisation	Website
ASI	Austria	Austrian Standards Institute	www.austrian-standards.at
NBN	Belgium	Bureau de Normalisation/Bureau voor Normalisatie	www.nbn.be
BDS	Bulgaria	Bulgarian Institute for Standardization	www.bds-bg.org
HZN	Croatia	Croatian Standards Institute	www.hzn.hr
CYS	Cyprus	Cyprus Organization for Standardisation	www.cys.org.cy
UNMZ	Czech Republic	Czech Office for Standards, Metrology and Testing	www.unmz.cz
DS	Denmark	Dansk Standard	www.ds.dk
EVS	Estonia	Estonian Centre for Standardisation	www.evs.ee
SFS	Finland	Suomen Standardisoimisliitto r.y.	www.sfs.fi
ISRM	Former Yugoslav Republic of Macedonia	Standardization Institute of the Republic of Macedonia	www.isrm.gov.mk
AFNOR	France	Association Française de Normalisation	www.afnor.org
DIN	Germany	Deutsches Institut für Normung	www.din.de
NQIS/ELOT	Greece	National Quality Infrastructure System	www.elot.gr
MSZT	Hungary	Hungarian Standards Institution	www.mszt.hu
IST	Iceland	Icelandic Standards	www.stadlar.is
NSAI	Ireland	National Standards Authority of Ireland	www.nsai.ie
NSAI	Ireland	National Standards Authority of Ireland	www.nsai.ie
UNI	Italy	Ente Nazionale Italiano di Unificazione	www.uni.com
LVS	Latvia	Latvian Standard Ltd.	www.lvs.lv
LST	Lithuania	Lithuanian Standards Board	www.lsd.lt
ILNAS	Luxembourg	Organisme Luxembourgeois de Normalisation	www.portail-qualite.lu
MCCAA	Malta	The Malta Competition and Consumer Affairs Authority	www.mccaa.org.mt
NEN	Netherlands	Nederlands Normalisatie-instituut	www.nen.nl
SN	Norway	Standards Norway	www.standard.no/
PKN	Poland	Polish Committee for Standardization	www.pkn.pl
IPQ	Portugal	Instituto Português da Qualidade	www.ipq.pt
ASRO	Romania	Romanian Standards Association	www.asro.ro
UNMS	Slovakia	Slovak Office of Standards Metrology and Testing	www.unms.sk
SIST	Slovenia	Slovenian Institute for Standardization	www.sist.si
AENOR	Spain	Asociación Española de Normalización y Certificación	www.aenor.es
SIS	Sweden	Swedish Standards Institute	www.sis.se
SNV	Switzerland	Schweizerische Normen-Vereinigung	www.snv.ch
TSE	Turkey	Turkish Standards Institution	www.tse.org.tr
BSI	United Kingdom	British Standards Institution	www.bsigroup.com

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 680570

3.3 Procedure for producing standards

The standardization activities of CEN are steered by the CEN Technical Board (BT), who has full responsibility for the execution of CEN's work programme. Standards are prepared by Technical Committees (TCs). Each TC has its own field of operation (scope) within which a work programme of identified standards is developed and executed. TCs work on the basis of national participation by the CEN Members, where delegates represent their respective national point of view. This principle allows the TCs to take balanced decisions that reflect a wide consensus.

A Subcommittee can be established within a TC, in the case of large programs of work.

The real standards development is undertaken by Working Groups (WGs) where experts, appointed by the CEN Members but speaking in a personal capacity, come together and develop a draft that will become the future standard. This reflects an embedded principle of 'direct participation' in the standardization activities.

3.4 CEN Committees relevant to MAESTRI

This section lists the CEN Committees whose work is relevant to MAESTRI. The listed Committees are working in the fields of environment management, energy management and information processing Systems. This list is not exhaustive nor final. During the course of the project it may be updated.

3.4.1 Technical Committees on the environment

Every standard, even if related to product, service, or process, has an environmental impact. For a product this can vary according to the different stages of the product life cycle, such as production, distribution, use, and end-of-life. To this purpose, CEN has recently been playing a major role in reducing environmental impacts by influencing the choices that are made in connection with the design of products and processes.

CEN faces environmental challenges posed by the operational activities of the CEN Sectors as well as by developments within the European Union.

According to the Treaty that establishes the European Community "Environmental protection requirements must be integrated into the definition and implementation of the Community policies and activities, in particular with a view to promoting sustainable development".

Standards are supporting the implementation of the EU policies and as such should also be a tool supporting the protection of the environment.

Environment is an interdisciplinary topic, therefore, all CEN sectors deal with environmental issues.

CEN has in place an organizational structure to respond to the challenges posed by the developments within the various sectors, as well as by the evolution of the legislation within the European Community. The main bodies within CEN are:

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 680570

1. The Strategic Advisory Body on the Environment (SABE) – an advisory body for the CEN Technical Board on issues related to environment. Stakeholders identify environmental issues of importance to the standardization system and suggest corresponding solutions.

2. The CEN Environmental Helpdesk (EHD) provides support and services to CEN Technical Bodies on how to address environmental aspects in standards.

3. Sectors – some sectors established a dedicated environmental body to address environmental matters associated with their specific needs, such as the Construction Sector Network Project for the Environment (CSNPE).

4. Associates – two CEN associate members provide a particular focus on the environment within standardization:

   - European Environmental Citizens Organization for Standardization (ECOS);
   - European Association for the Coordination of Consumer Representation in Standardization (ANEC).

Table 2 lists the technical committees on the environment.

Table 2 - Technical committees on the environment

Technical Committee	Title
CEN/TC 223	Soil improvers and growing media
CEN/TC 230	Water analysis
CEN/TC 264	Air quality
CEN/TC 292	Characterization of waste
CEN/TC 308	Characterization of sludges
CEN/TC 345	Characterization of soils
CEN/TC 351	Construction Products – Assessment of release of dangerous substances
CEN/TC 366	Materials obtained from end-of-Life Tyres (ELT)
CEN/TC 406	Project Committee - Mechanical Products - Ecodesign Methodology

There are several standards on environmental management. To exemplify this, Table 3 reports the list of standards grouped in accordance with the committee **CEN/SS S26 – environmental management.**

Table 3 - Committee CEN/SS S26 – environmental management

Standard	Title
CEN ISO/TS 14071:2016	Environmental management - Life cycle assessment - Critical review processes and reviewer competencies: Additional requirements and guidelines to ISO 14044:2006 (ISO/TS 14071:2014)
EN ISO 14004:2016	Environmental management systems - General guidelines on implementation (ISO 14004:2016)
EN ISO 14021:2016	Environmental labels and declarations - Self-declared environmental claims (Type II environmental labelling) (ISO 14021:2016)
EN ISO 14046:2016	Environmental management - Water footprint - Principles, requirements and guidelines (ISO 14046:2014)
EN ISO 14001:2015	Environmental management systems - Requirements with guidance for use (ISO 14001:2015)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 680570

Standard	Title
CEN ISO/TS 14067:2014	Greenhouse gases - Carbon footprint of products - Requirements and guidelines for quantification and communication (ISO/TS 14067:2013)
EN ISO 14031:2013	Environmental management - Environmental performance evaluation - Guidelines (ISO 14031:2013)
EN ISO 14065:2013	Greenhouse gases - Requirements for greenhouse gas validation and verification bodies for use in accreditation or other forms of recognition (ISO 14065:2013)
EN ISO 14045:2012	Environmental management - Eco-efficiency assessment of product systems - Principles, requirements and guidelines (ISO 14045:2012)
EN ISO 14064-1:2012	Greenhouse gases - Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals (ISO 14064-1:2006)
EN ISO 14064-2:2012	Greenhouse gases - Part 2: Specification with guidance at the project level for quantification, monitoring and reporting of greenhouse gas emission reductions or removal enhancements (ISO 14064-2:2006)
EN ISO 14064-3:2012	Greenhouse gases - Part 3: Specification with guidance for the validation and verification of greenhouse gas assertions (ISO 14064-3:2006)
EN ISO 14006:2011	Environmental management systems - Guidelines for incorporating ecodesign (ISO 14006:2011)
EN ISO 14051:2011	Environmental management - Material flow cost accounting - General framework (ISO 14051:2011)
EN ISO 14015:2010	Environmental management - Environmental assessment of sites and organizations (EASO) (ISO 14015:2001)
EN ISO 14025:2010	Environmental labels and declarations - Type III environmental declarations - Principles and procedures (ISO 14025:2006)
EN ISO 14050:2010	Environmental management - Vocabulary (ISO 14050:2009)
EN ISO 14063:2010	Environmental management - Environmental communication - Guidelines and examples (ISO 14063:2006)
EN ISO 14040:2006	Environmental management – Life cycle assessment – Principles and framework (ISO 14040:2006)
EN ISO 14044:2006	Environmental management – Life cycle assessment – Requirements and guidelines (ISO 14044:2006)
EN ISO 14020:2001	Environmental labels and declarations - General principles (ISO 14020:2000)
EN ISO 14024:2000	Environmental labels and declarations - Type I environmental labelling - Principles and procedures (ISO 14024:1999)

3.4.2 Technical Committees on energy management

Making better and more rational use of energy and managing our energy more efficiently has become essential for the sustainable development of our society. Standardization can contribute to this objective by promoting best practices and providing organisations with the tools to take decision and design sound policies, optimise installations and systems and improve energy efficiency.

List of CEN and CENELEC Joint Working Groups operating in the area of energy management and the standards under development:

- **CEN/CLC JWG1 -** Energy Audits
- **CEN/CLC JWG3** - Energy management and services- General requirement and qualification procedures (previously CEN/CLC/BT/TF 189)
- **CEN/CLC JWG4** - Energy efficiency and saving calculation (previously CEN/CLC BT/TF 190)
- **CEN/CLC JWG9** - Energy measurement plan for organisations

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 680570

In 2006 the Sector Forum 'Energy Management' was created as a joint CEN and CENELEC platform. The creation of this Sector Forum was one of the recommendations of the CEN-CENELEC BT Joint Working Group on Energy Management (2002 - 2005) which in its final report identified a series of standardization priorities in the field of energy management and advised to create a platform to develop a common general strategy for the improvement of energy efficiency standardization.

A Sector Forum is a platform aiming at facilitating the exchange of information between the different stakeholders, coordinating and identifying standardization needs and overlaps in a specific field of standardization work.

The CEN-CENELEC Sector Forum Energy Management (SFEM) acts as an advisory and coordination body on policy and strategic matters in relation to standardization in the area of energy management.

Table 4 lists the standards published by CEN and CENELEC Joint Working Groups.

Table 4 - Committee CEN/SS S26 – environmental management

Standard	Title	CEN and CENELEC Joint Working Groups
EN 16247-1:2012	Energy audits - Part 1: General requirements	**CEN/CLC JWG1**
EN 16247-2:2014	Energy audits - Part 2: Buildings	
EN 16247-3:2014	Energy audits - Part 3: Processes	
EN 16247-4:2014	Energy audits - Part 4: Transport	
EN 16247-5:2015	Energy audits - Part 5: Competence of energy auditors	
EN 15900:2010	Energy efficiency services - Definitions and requirements	**CEN/CLC/JWG 3** (Scope: To elaborate EN standards in the energy management and related services field: - Energy Management Systems: definition and requirements - Energy Service Companies (ESCO): definition, requirements and qualification procedures - Energy Managers and Experts: roles, professional requirements and qualification Procedures)
EN 16231:2012	Energy efficiency benchmarking methodology	
EN ISO 50001:2011	Energy management systems - Requirements with guidance for use (ISO 50001:2011)	
EN 16212:2012	Energy Efficiency and Savings Calculation, Top-down and Bottom-up Methods	**CEN/CLC/JWG 4 – Energy efficiency and saving calculation** (Scope: Standards for common methods of calculation of energy consumption, energy efficiencies and energy savings and for a common measurement and verification of protocol and methodology for energy use indicators)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 680570

3.4.3 Technical Committee on Information Processing Systems

Table 5 lists the standards published by Committee CEN/SS F12 – Information processing systems.

Table 5 - Committee CEN/SS F12 – Information processing systems

Standard	Title
EN ISO/IEC 27037:2016	Information technology - Security techniques - Guidelines for identification, collection, acquisition and preservation of digital evidence (ISO/IEC 27037:2012)
EN ISO/IEC 27038:2016	Information technology - Security techniques - Specification for digital redaction (ISO/IEC 27038:2014)
EN ISO/IEC 27040:2016	Information technology - Security techniques - Storage security (ISO/IEC 27040:2015)
EN ISO/IEC 27041:2016	Information technology - Security techniques - Guidance on assuring suitability and adequacy of incident investigative method (ISO/IEC 27041:2015)
EN ISO/IEC 27042:2016	Information technology - Security techniques - Guidelines for the analysis and interpretation of digital evidence (ISO/IEC 27042:2015)
EN ISO/IEC 27043:2016	Information technology - Security techniques - Incident investigation principles and processes (ISO/IEC 27043:2015)
EN ISO/IEC 30121:2016	Information technology - Governance of digital forensic risk framework (ISO/IEC 30121:2015)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 680570

4 State-of-the-art in standardization initiatives

Standards play an important role in the MAESTRI Total Efficiency Framework. The work developed within MAESTRI takes strongly into consideration standards currently available. Previous deliverables from WP2, WP3 and WP4 have considered standards.

This section presents an overview of some standardization initiatives that may be relevant to MAESTRI's work.

4.1 Industrial Symbiosis

At firm level, the quality of waste data can potentially be a major issue to enable synergies creation. Thus, the development of integrated standards related to waste characteristics and measurement technologies could be key enabler for information sharing. Standards and technologies have already been indicated as key enablers for Industrial Symbiosis (IS) implementation[8].

There is a great number of standards (a recent research from the British Standard Institution [9][10] found over 200 different standards, considering national, European and international standards) regarding waste prevention and management, and the circular economy topic, often causing disorientation and uncertainty among industrial companies willing to implement them. Thus, consolidation of and addition to existing standards is an option that interested stakeholder should thoroughly consider before starting developing new standards.

In the following table, we have synthesized (mainly focusing on standard that are relevant to the European Union and to the industrial symbiosis topic in particular) and updated the research produced by BSI.

Table 6 - International and European standards related to waste management and industrial symbiosis.

INTERNATIONAL STANDARDS	
ISO 18603	Specifies the requirements for a packaging to be classified as reusable and sets out procedures for assessment of meeting the requirements, including the associated systems
ISO 18604	Specifies the requirements for packaging to be classified as recoverable in the form of material recycling and sets out procedures for assessment of meeting its requirements
ISO 18605	Specifies the requirements for packaging to be classified as recoverable in the form of energy recovery and sets out assessment procedures for fulfilling the requirements
ISO 18606	Specifies procedures and requirements for packaging that are suitable for organic recycling
ISO 16075 (parts 1, 2 & 3)	Contains guidelines for the development and the execution of projects intending to use treated wastewater (TWW) for irrigation and considers the parameters of climate and soil, criteria for the design of TWW irrigation projects and covers the issues related to the main components of a TWW irrigation project.

[8] Grant, G. B., Seager, T. P., Massard, G., & Nies, L. (2010). Information and communication technology for industrial symbiosis. Journal of Industrial Ecology, 14(5), 740-753.
[9] BSI (British Standard Institution), (2014), "Waste prevention and the circular economy. Due diligence research report".
[10] BSI (British Standard Institution), (2014), "Waste prevention and the circular economy. Stakeholder forum report".

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 680570

ISO 14001	Sets out the criteria for an environmental management system and can be certified to
ISO 14040	Specifies the principles and framework for a life cycle assessment (LCA)
ISO 14044	Details the requirements and guidelines for conducting an LCA
ISO 14046	Specifies principles, requirements and guidelines related to water footprint assessment of products, processes and organizations based on life cycle assessment (LCA)
ISO/TS 20245	Establishes minimum screening criteria for second-hand goods that are traded, sold, offered for sale, donated, or exchanged between countries
EUROPEAN STANDARDS	
EN 13427	Packaging. Requirements for the use of European Standards in the field of packaging and packaging waste
EN 13428	Packaging. Requirements specific to manufacturing and composition. Prevention by source reduction
EN 13429	Packaging. Reuse
EN 13430	Packaging. Requirements for packaging recoverable by material recycling
EN 13431	Packaging. Requirements for packaging recoverable in the form of energy recovery, including specification of minimum inferior calorific value
EN 13432	Packaging. Requirements for packaging recoverable through composition and biodegradation. Test scheme and evaluation criteria for the final acceptance of packaging
EN 13437	Packaging and material recycling. Criteria for recycling methods. Description of recycling processes and flow chart
EN 15343 – EN 15348 European plastic recycling standards	Cover the characterisation of various types of plastics and plastic wastes.
EN 50625-1	Collection, logistics & treatment requirements for Waste Electrical and Electronic Equipment. General treatment requirements
EN 15864	Characterisation of waste – Leaching behaviour test for basic characterisation – Dynamic Monolithic Leaching Test with continuous leachant renewal under conditions relevant for specified scenario(s)
EN 50574	Collection, logistics & treatment requirements for end-of-life household appliances containing volatile fluorocarbons or volatile hydrocarbons
EN 50614	Requirements for the preparation for re-use of waste electrical and electronic equipment

The majority of standards work, to date, has focused on various aspects of waste management and prevention, rather than the circular economy per se. The majority of the standards of relevance to waste prevention and, indirectly, to industrial symbiosis, explore issues of material recycling, recoverability, re-use and re-manufacturing, usually in the context of a specific industry and/or material group (such as plastics, paper, metals, etc.).

There has been some recent development in this sense, as BSI is about to release a new national standard, "*BS 8001 Framework for implementing circular economy principles in organisations – Guide*", which is the first standard released worldwide focusing on circular economy topics in general. This is intended to continually improve an organization's transition from a linear to a more sustainable circular mode of operation. It provides circular economy principles that should be considered when applying the proposed framework for action.

The framework will guide organizations through the interest/scoping phase, progressing them to piloting/exploration phase, before moving into the implementation steps. To support the framework, BS 8001 will provide guidance around the specific issues surrounding the transition to a circular model (e.g. logistics, measurement, liability & insurance, materials.), as well as guidance on the specific associated business models (remanufacturing, leasing, sharing economy, etc.).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 680570

4.2 MANAGEMENT SYSTEMS

Out of the internationally recognized standards related to management some cover the topics of various management systems like quality management system (ISO 9001), occupational health and safety management system (ISO 45001), energy management system (ISO 50001) or environmental management system (ISO 14001). Additionally, there are internationally recognized standards related to management issues, namely ISO 10006 (Quality management systems -- Guidelines for quality management in projects) and ISO 13053 (Quantitative methods in process improvement -- Six Sigma). Most of these norms have been described in D2.1 Efficiency Framework concept description. Even though all these norms are related to MAESTRI consortium developments within WP3 Management System none of them covers the topic of establishing and maintaining a management system at an industrial plant.

It is common, especially for large manufacturing companies to use best practices, benchmarking, competences of their employees and external support to develop organization-wide systems that support management on various levels of the organization: from the front line up to the top. Company-specific systems include for example: Toyota Production System, Volvo Production System, John Deere Production System, Siemens Production System, etc.[11]. These systems usually define aspects in the areas of visual control, structure of meetings, structure of boards used to track performance, problem solving process, improvement suggestion process, breakdown prevention system, health and safety procedures etc.

4.3 INTERNET of THINGS and ICT

Several standardization initiatives [12] currently co-exist, in individual Standard Developing Organizations (SDOs) or in partnerships (for example IoT-European Platforms Initiative, OneM2M, Industrial Internet Consortium IIC, IEEE) and also in conjunction with a number of industrial initiatives (for example AllSeen Alliance, Industrial Internet Consortium and Platform Industrie 4.0).

4.3.1 IoT-European Platforms Initiative (IoT-EPI)

IoT-European Platforms Initiative (IoT-EPI) [13] is a European Initiative addressing the new EU-funded H2020 programs about IoT platform development. At the core of IoT-EPI are the seven research and innovation projects: Inter-IoT, BIG IoT, AGILE, symbIoTe, TagItSmart!, VICINITY and bIoTope.

The IoT-EPI is coordinated by two consortia: UNIFY-IoT and Be-IoT. While the consortium Unify deals with technology-oriented fields such as Interoperability and Standardisation, the main

[11] Netland, T. (2013). Exploring the phenomenon of company-specific production systems: one-best-way or own-best-way? International Journal of Production Research, 51(4), 1084–1097. https://doi.org/10.1080/00207543.2012.676686.

[12] http://www.internet-of-things-research.eu/pdf/Digitising_the_Industry_IoT_IERC_2016_Cluster_eBook_978-87-93379-82-4_P_Web.pdf

[13] http://iot-epi.eu/

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 680570

goal of the consortium Be-IoT is to build an adopter's ecosystem focussing on developers, entrepreneurs and end-users.

UNIFY-IoT[14] is the "working partner" of the Alliance for Internet of Things Innovation (AIOTI)[15] and the Internet of Things European Research Cluster (IERC)[16] by coordinating and supporting the activities on innovation ecosystems, IoT standardisation, policy issues, research and innovation.

Moreover, UNIFY-IoT drives new collaborative IoT business models and market developments to foster the European IoT digital economy in a global perspective, through the creation of an interoperable and secure ecosystem of established and emerging IoT solutions and approaches.

Be-IoT supports the cooperation and knowledge exchange between pilots and other IoT-related EU-projects, build the bridge between pilots and relevant stakeholders and thus expand the ecosystem further, set the ground for upcoming business building activities by creating awareness and also by facilitating and fostering societal acceptance.

4.3.2 oneM2M

oneM2M is the global standards initiative for Machine to Machine Communications and the Internet of Things. oneM2M was established through an alliance of standards organizations to develop a single horizontal platform for exchange and sharing of data among all applications. The alliance includes eight of the world's leading ICT standards bodies, six global fora and Standards Development Organisation (SDOs), over 200 companies from all industrial sectors.

oneM2M is creating a distributed software layer which is facilitating that unification by providing a framework for interworking with different technologies. In specific industrial domain, oneM2M published a technical report called "Industrial Domain Enablement"17 that collects the use cases of the industrial domain and the requirements needed to support collectively. Furthermore, the Technical Report also identifies necessary technical work needing to be addressed while enhancing future oneM2M specifications.

[14] http://www.unify-iot.eu/
[15] http://www.aioti.org/
[16] http://www.internet-of-things-research.eu/
[17] http://www.onem2m.org/images/files/deliverables/Release2/TR-0018-Industrial_Domain_Enablement-V2_0_0.pdf

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 680570

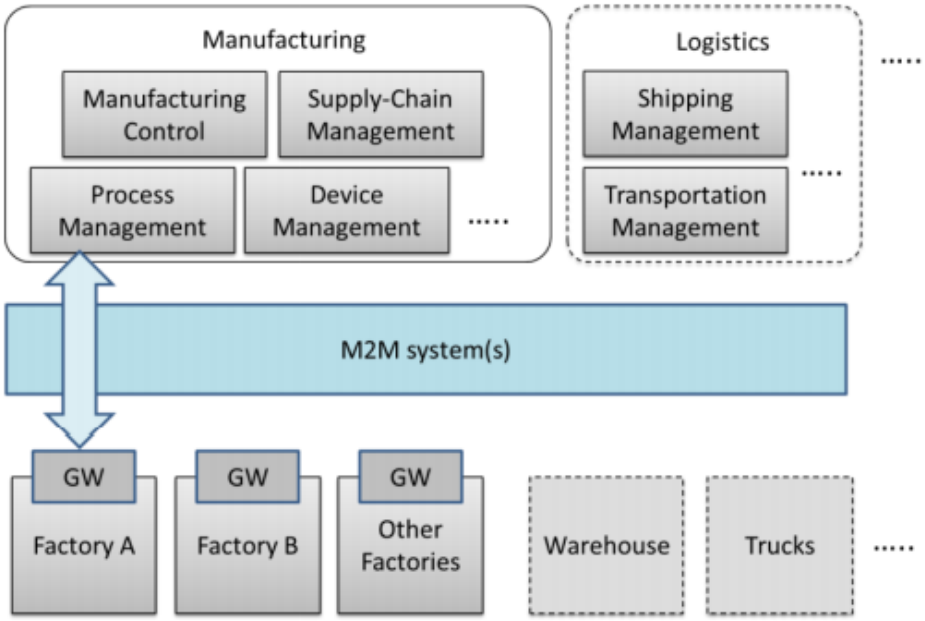


Figure 3: Industrial Domain Architecture

An example of architecture overview is shown in Figure 3. The figure shows that the factories are connected with manufacturing services via the M2M system(s). Generally, the gateway in the factory collects data from the factory and send it to manufacturing services in a management centre.

4.3.3 Industrial Internet Consortium (IIC)

The Industrial Internet Consortium (IIC)[18] was founded in March 2014 to bring together the organizations and technologies necessary to accelerate the growth of the Industrial Internet by identifying, assembling and promoting best practices. Membership includes small and large technology innovators, vertical market leaders, researchers, universities and government organizations.

The main goals of this Consortium are:

- drive innovation through the creation of new industry use cases and testbeds for real-world applications
- define and develop the reference architecture and frameworks necessary for interoperability
- influence the global development standards process for internet and industrial systems
- facilitate open forums to share and exchange real-world ideas, practices, lessons, and insights
- build confidence around new and innovative approaches to security.

The Industrial Internet Consortium (IIC) published technical report called "*The Industrial Internet of Things Volume G1: Reference Architecture*"[19] containing an Industrial Internet Architecture

[18] http://www.iiconsortium.org/
[19] http://www.iiconsortium.org/IIC_PUB_G1_V1.80_2017-01-31.pdf

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 680570

Framework (IIAF) and an Industrial Internet Reference Architecture (IIRA) for Industrial Internet of Things (IIoT) systems.

The Industrial Internet Consortium collected needs from many stakeholders and it used "*ISO/IEC/IEEE 42010:2011 Systems and Software Engineering–Architecture Description*"[20] to define the Industrial Internet Architecture Framework (IIAF). The IIAF identifies conventions, principles and practices for consistent description of IIoT architectures. This standard-based architecture framework facilitates easier evaluation, and systematic and effective resolution of stakeholder concerns. Figure 4 shows the Architecture Framework.

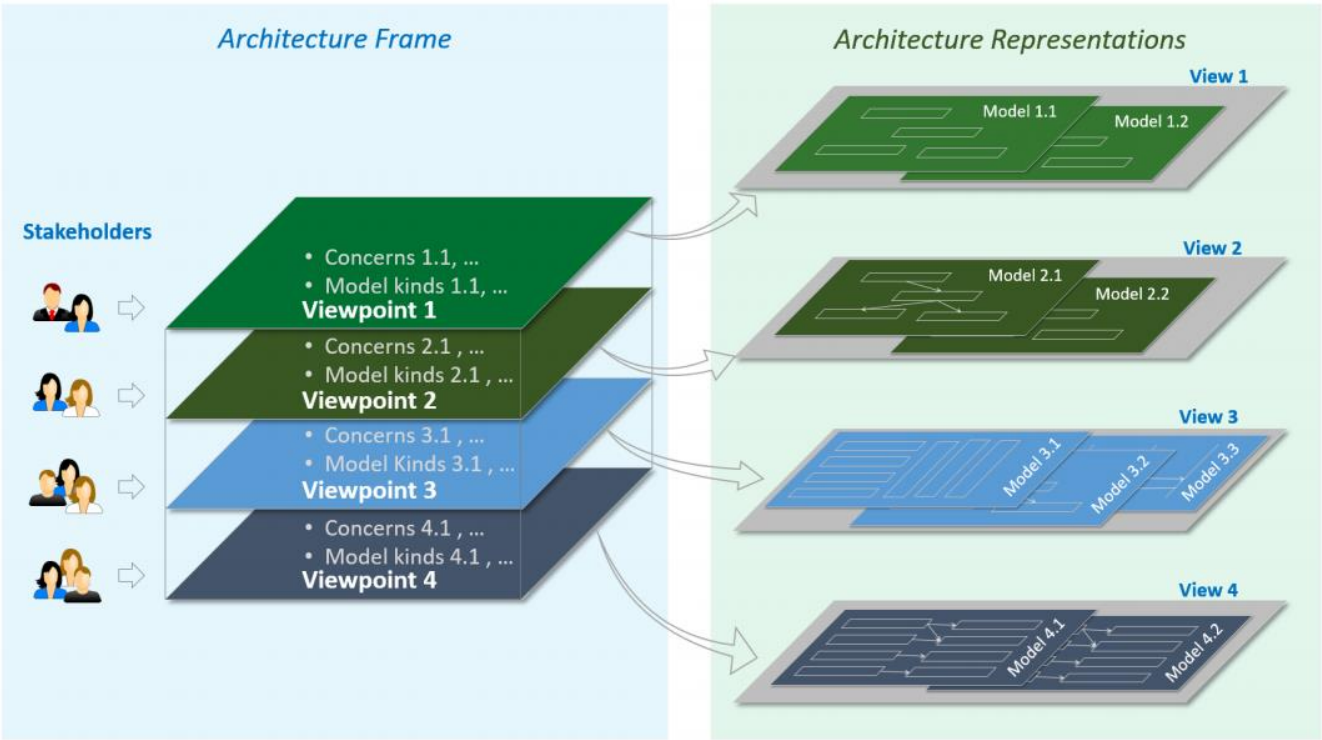


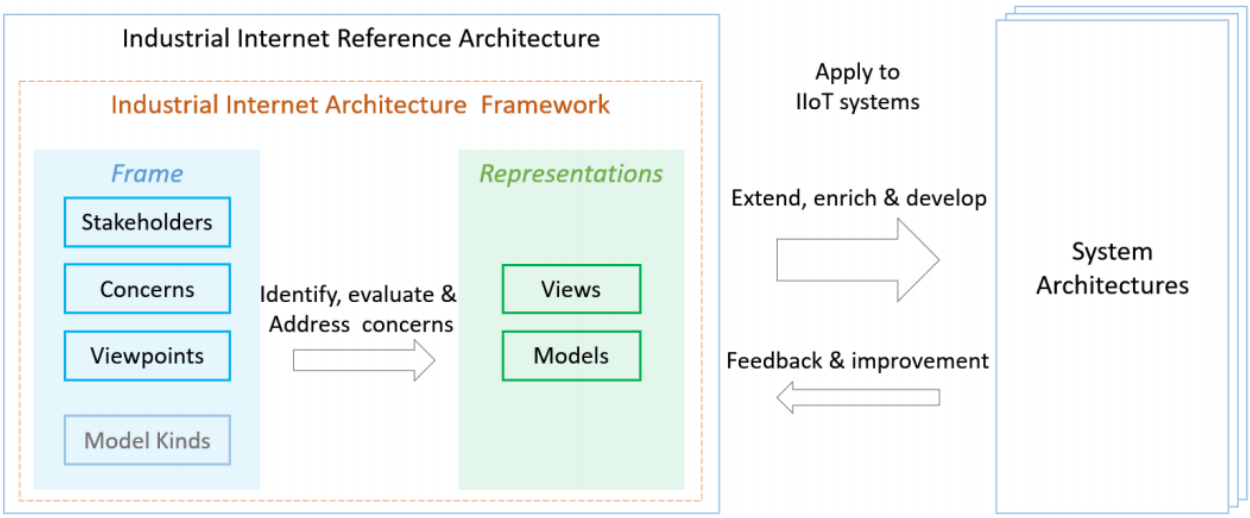
Figure 4: Architecture Framework

The IIRA (see Figure 5) is a standards-based open architecture for IIoT systems. The IIRA maximizes its value by having broad industry applicability to drive interoperability, to map applicable technologies, and to guide technology and standard development. The architecture description and representation are generic and at a high level of abstraction to support the requisite broad industry applicability.

[20] http://www.iso.org/iso/catalogue_detail.htm?csnumber=50508

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 680570

Figure 5: IIRA constructs and application



4.3.4 P2413 - Standard for an Architectural Framework for the Internet of Things

P2413[21] is a IEEE project that it aims to define an architectural framework for the Internet of Things (IoT), including descriptions of various IoT domains, definitions of IoT domain abstractions, and identification of commonalities between different IoT domains. The architectural framework for IoT provides a reference model that defines relationships among various IoT verticals and common architecture elements. Furthermore, this standard provides a reference architecture that builds upon the reference model. The reference architecture covers the definition of basic architectural building blocks and their ability to be integrated into multi-tiered systems. The reference architecture also addresses how to document and, if strived for, mitigate architecture divergence.

4.3.5 Standard Industrial protocols

4.3.5.1 EUROMAP

EUROMAP was established 1964 and is the umbrella organisation for the powerful European plastics and rubber machinery industry. EUROMAP sets technical standards reflecting state of the art technology. Those standards focus on interfaces, energy efficiency and Industry 4.0.

The main standards for MAESTRI project are:

- EUROMAP 63[22] is a standard that defines data exchange interface between Injection Moulding Machines (IMM) and Manufacturing execution Systems (MES).

[21] http://grouper.ieee.org/groups/2413/
[22] http://www.euromap.org/euromap-63

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 680570

- EUROMAP 77[23] is the new Industry 4.0 ready industry standard for the exchange of data between Injection Moulding Machines (IMM) and Manufacturing execution Systems (MES). MES are used for collecting the information generated by IMM at a central point for easier quality assurance and job and dataset management. The target of EUROMAP 77 is to provide a unique interface for IMM and MES from different manufacturers to ensure compatibility.

4.3.5.2 OPC UA

OPC is the interoperability standard for the secure and reliable exchange of data in the industrial automation space and in other industries. It is platform independent and ensures the seamless flow of information among devices from multiple vendors.

With the introduction of service-oriented architectures in manufacturing systems came new challenges in security and data modelling. The OPC Foundation[24] developed the OPC Unified Architecture (UA)[25] specifications to address these needs and at the same time provided a feature-rich technology open-platform architecture that was future-proof, scalable and extensible. The OPC UA, released in 2008, is a platform independent service-oriented architecture that integrates all the functionality of the individual OPC Classic specifications into one extensible framework.

4.3.5.3 MTConnect Institute

MTConnect Institute's[26] mission is to create open standards to foster greater interoperability between devices and clients by defining the structure and terminology used in communications in the discrete parts manufacturing sector.

The main goals of Institute are:

- reduce the complexity of interfacing equipment, devices, and software applications
- facilitate the adoption, implementation, and expansion of the MTConnect standard
- create a sustainable funding strategy for the MTConnect Institute.

MTConnect is an open and royalty-free set of standards designed as a universal factory floor communications protocol. MTConnect is intended specifically for the shop floor environment. While there are numerous communication solutions available, MTConnect defines a "dictionary" for manufacturing data.

4.3.5.4 MTConnect-OPC UA

In September 2010, the OPC Foundation and the MTConnect Institute signed a memorandum of understanding to provide a mechanism for OPC and MTConnect to collaborate to extend the reach of the existing manufacturing data exchange standards and implementation technologies. The outcome of that agreement is this companion specification called MTConnect-OPC UA[27].

[23] http://www.euromap.org/files/EUROMAP77_RC1_00.pdf
[24] https://opcfoundation.org/
[25] https://opcfoundation.org/developer-tools/specifications-unified-architecture
[26] http://www.mtconnect.org/
[27] http://www.mtconnect.org/opc-ua-companion-specification/

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 680570

The specification is built on open standards, backed by both the MTConnect Institute and the OPC Foundation, which represent hundreds of companies, individuals, government organizations and non-profits, all working toward the goal of increased productivity in manufacturing.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 680570

5 MAESTRI'S strategy for engaging standard bodies

5.1 Introduction

Standards are an important mechanism for knowledge transfer. There is empirical economic evidence relating standards with productivity gains (including case studies of the benefits of standards for individual companies). A substantial body of evidence shows that the use of standards has positive impacts on product, service and process innovation, whether as a direct input (e.g. codified knowledge and best practice), as a complementary knowledge asset or as a contributor to the creation of market demand. The complementarities can include joint use of standards with scientific and technical literature, enabling research within businesses and academia and also facilitating collaboration between firms and with other organizations.

This is illustrated in more detail in Figure 6, which shows flows of both 'codified' and 'tacit' knowledge between the different parts of the system[28].

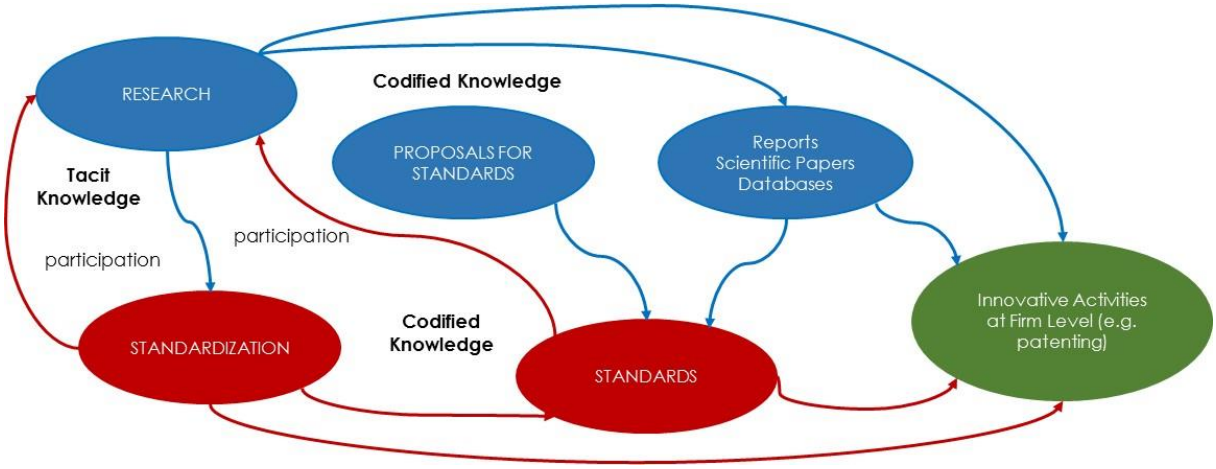


Figure 6: Knowledge Transfer Links

This figure highlights the significance of codified knowledge, not just in the form of standards, but also as scientific publications that form a major element in the motivation and incentive structure of the research community. It also illustrates the fact that knowledge flows take place not only through direct use of research publications or participation of researchers in standardization activity and vice versa, but also through the channel of the firm itself which, in its innovation activities is the primary vehicle for integrating knowledge emanating from both research and standardization. This includes of course decisions about patenting and other innovation activities.

The main knowledge flows:

- Codified knowledge seems to flow quite well from standards to research but the reverse does not appear to be the case. The main flow of codified knowledge from research is likely to be through the traditional route of scientific publications. There may be options for encouraging some codified research outputs in

[28] Research Study on the Benefits of Linking Innovation and Standardization, Final report, December 2014, CEN/CENELEC

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 680570

standardization friendly forms, for example through the criteria used in policies for research assessment and the indicators used in bibliometrics.

- The flow of tacit knowledge between the research and standardization systems seems rather lower, except in the domain of metrology. It is not clear though whether this is at a sub-optimal level, given the opportunity and resource costs of researchers' joining standardization committees.
- A major flow of tacit knowledge between the standardization community and researchers takes place within firms/organizations. We found no evidence in the surveys that the perceptions of the benefits of participation of those who individually participate (i.e. Technical Committee members) differed from those who belong to organizations which participate, suggesting that tacit knowledge flows appropriately within organizations.

So this shows that there are already mechanisms for the standardization and research communities to engage with each other. However, they are not currently optimised and more needs to be done to facilitate and enhance engagement.

5.2 Objectives for the Interaction of MAESTRI with Standard Bodies

Sometimes a project from the early proposal stages has a clear objective that research results will be proposed as new standards for industry. But, not all projects that eventually include standardisation activities start with a specific objective of creating a new industry standard. Some see standardisation as less important because they are developing innovations above the technology layer where standards exist, while others see their role as only assembling and integrating standards-based technologies to create new platforms or frameworks.

Within MAESTRI, we have considered standardization activities still in the proposal stage. The scope and range of interaction is better specified at this stage of the project taking into account the current developments and expected results.

Before start thinking which standards or standardization processes to pursue as a project, it is best to determine first how MAESTRI should plan to interface with standards bodies. Standardization involves an unusual combination of interdependent project activities, some of which are research and development related, and some of which are more aligned with dissemination. A project that intends to impact or contribute to standards needs to address this diverse set of tasks in its project plans, and consider which partners are most appropriate to lead each task.

Subsequently, the results that MAESTRI seeks to achieve through its interfacing with standardization must be held against the type of deliverables that may result from a standardization process, and the process steps we would have to participate in.

Identifying areas for possible cooperation with standards bodies should be done early. In MAESTRI we have decided that we should look for standards impacting the technical development areas, i.e industrial symbiosis, energy and environmental efficiency, and IoT.

The first step was to identify for each work package what are all of the outputs. Then, for each output, ask the following questions:

1. Does the output rely on an existing standard?

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 680570

2. Will the output be exploited by organisations already using standards for their products or services?
3. If an industry standard changed, would the output need to be modified?
4. Is the output a basis for commercial companies to develop new products or services?
5. Does the output need to be used consistently by industry for the project to deliver expected benefits?
6. Is the output intended to encourage many other organisations to create compatible technologies?
7. Will products from multiple suppliers utilise the output?
8. Is the output essential for the correct operations of higher level features and capabilities?
9. Will the output fill a gap or address an area only partially covered by an existing standard?

If one or more answers to the above are affirmative for one of the outputs, then it is likely that some interactions with standards bodies should be planned within the project.

As the questions that are affirmative are in the top half, as is the case in MAESTRI, then MAESTRI will mainly need to monitor activities of relevant standards bodies.

If the questions that are affirmative were in the bottom half of the list, then it is likely that contributions to standards would be an important element of the project if it is to achieve good results. Proactive participation and significant interactions with standards bodies would likely be required, and it would be advisable to consider thinking about standardization in time.

In determining whether a project should include plans to interface with standards bodies, there are no simple rules or formulas. However, there are some common characteristics that can help identify if a project is likely to need activities related to standardisation. For doing so we had to consider if MAESTRI project has one or more of the following characteristics:

- Adding domain-specific elements to an existing standard – projects often overlook the need to establish consensus within the specific domain concerning new elements.
- Using an existing standard for an application not originally envisioned – the original specification often needs to be extended or modified in some way when used for applications not originally envisioned when the standard was created.
- Integrating different standards into a platform, framework or architecture – usually more complicated than most researchers realise and often requiring modifications to one or more of the standards to avoid clumsy workarounds.
- Dissemination channel to end users has several vendors each with small market shares – if there are many customers and many suppliers, standardisation becomes the critical path to ensure project results are widely disseminated.
- Research results are intended as basis for a new generation of products or services – industrial organisations considering developing new products will often require standardisation processes be underway in order to reduce investment risk.

In MAESTRI we are integrating different standards into a platform and as such we will gain from establishing contacts with the standards bodies and by following the standards development. In MAESTRI, although we do not have a specific goal of contributing to standards, we still found

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 680570

that broad dissemination and take-up of research results would gain from interfacing with standards bodies.

There is already a high standardization pressure regarding energy management, waste management, industrial symbiosis, circular economy in general, and IoT/ICT from several different entities and at different levels. Thus, actions for MAESTRI will have the objective of monitoring standards' proliferation in these sectors and to the potential impact of different standards on the project results.

5.3 Standard bodies to address

In section 4 we have identified the standards that are most relevant to MAESTRI in the different fields of work. Here we list the standard bodies that we will be targeting.

Standards bodies currently dealing with waste management and industrial symbiosis/circular economy topics are:

- BSI, British Standard Institution;
- ISO, International Standards Organization;
- CEN & CENELEC.

In addition, there are some institutions/associations that are developing private standards, such as:

- WRI, World Resource Institute: it has designed a global standard, called the "Global Food Loss and Waste Protocol", aiming to enable countries and companies to measure and monitor food loss and waste;
- Carbon Trust: it has launched the world's first international certification scheme to recognize firms that are effectively reducing their waste, and that can demonstrate achievement in managing and reducing waste output and improving resource efficiency;
- WRAP: it has created the PAS 141 Re-use Standard, a process management specification for the re-use of used and waste electrical and electronic equipment.

The most recognizable standards body dealing with management issues is the International Standards Organization (ISO).

Regarding IoT/ICT, on a European level, there are three formal standards organizations: CEN, CENELEC and ETSI. These are recognized by the EU and meet the WTO criteria for standards setting. All three have cooperation arrangements in place with their global counterparts: ISO, IEC and ITU. In addition, there are several formal standards bodies working on a national level, which also have wider impact (e.g. DIN, ANSI or BSI).

Many aspects of ICT standardization are however covered by other forums (e.g. W3C for the Web and the IETF for the Internet), industry consortia and trade organizations rather than by formal standards bodies.

During MAESTRI we will monitor the work of these standard bodies and report to the consortium partners.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 680570

5.4 Monitoring and follow-up actions

As we have decided that MAESTRI should monitor the work of standard bodies, it becomes important to include activities for these interactions as part of the project work plan. There are different aspects to be considered such as timing of interactions, the formal mechanisms that enable interactions, and the tasks that are needed to effectively monitor the standards development.

5.4.1 Timing of interactions

The monitoring of the standards bodies work will be made on a continuous way. The first step will be to select relevant ongoing standardization processes. The monitoring will be focused on those standards that are being developed or revised. Most standardisation processes require between 1 and 3 years, so it may be expected that during the remaining life of the project new developments will occur.

5.4.2 Mechanisms for interaction between MAESTRI and standardization

Planning MAESTRI's interaction with standards processes required an evaluation whether (temporary) membership of the targeted organization is desirable, or necessary to obtain the desired outcome. As we will be focusing on monitoring the standards and do not expect to develop new standards, or to contribute to new standards, we have decided that membership will not be necessary.

ISQ is member of several technical committees in the Portuguese national standardization body, IPQ, so for some standards (e.g. focusing on environmental issues) it has already some interactions established.

5.4.3 Tasks

The monitoring work will be split amongst the partners participating in Task 7.2, as follows:

- ISQ, INEGI, IZNAB: standards related with eco-efficiency, efficiency, energy management and environment subjects;
- ISMB, ATB, FIT: standards related with IoT and ICT;
- UCAM: standards related with circular economy/industrial symbiosis;
- LEI: standards related with management aspects.

The monitoring will involve the following tasks:

1. Identification of relevant standards currently being developed or revised;
2. Access the potential impacts on MAESTRI;
3. Report to the consortium partners the findings. This reporting should be made each 6 months until the end of the project. The Task leader (ISQ) will write the report with the contributions of the above referred partners. This will be an internal working document and will not be submitted to the EC.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 680570

6 Conclusions

The work being developed in MAESTRI relies on several developed standards. However, we do not expect, at least at this stage, that we will be developing new standards or contributing to the development of new ones. Nevertheless, we must keep track on the standards most relevant to our work and to new ones that may surface during the course of the project, as they may have an impact on our developments. Because of this we have decided that the relevant standards will be monitored. Findings of the monitoring will be reported on a 6-month basis to the consortium partners.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 680570