Project acronym	B4B
Project full name	Brains for Building's Energy Systems
Grant No	MOOI32004
Project duration	4 year (Starting date May 1, 2021)

Deliverable D4.08

Standardization of data management and integration results (NEN, CEN, ISO)

T. Guyt (NEN), R. Roeterdink (NEN), P. Pauwels (TUE)

Work package	WP4
Result	Result 9
Lead beneficiary	NEN
Due Date	31 December 2025
Deliverable Status	Final
File name	B4B WP4 D4.08 standardization of data management and integration results.docx
Reviewers	Ekaterina Petrova (TUE)

This project received funding from Dutch Ministry of Economic Affairs and Climate Policy and Ministry of the Interior and Kingdom Relations under the MOOI program

SAMENVATTING

Brains for Buildings' Energy Systems (B4B) is een meerjarig project met meerdere belanghebbenden dat tot doel heeft om slimme bouwmethoden te ontwikkelen om de activiteiten in gebouwen energie-efficiënter te maken, om flexibel energieverbruik mogelijk te maken, om comfort te verhogen van de gebruikers en om installatietechnisch onderhoud slimmer te maken. Dit wordt bereikt door snellere en efficiëntere modellen en algoritmen voor *Machine Learning (ML)* en *Artificial Intelligence* (AI) te ontwikkelen. Het project is afgestemd op bestaande utiliteitsbouw.

Vijf werkpakketten in dit project zijn gewijd aan bovenstaande taken. Dit rapport is een uitkomst van het Werkpakket 4 (WP4) van het B4B-project, met als thema "Data Integratie voor Slimme Communicatie". Er zijn veel heterogene gegevensbronnen in gebouwen, b.v. sensorgegevens, 3D-modelgegevens, tijdschema's, gegevens van bewoners, gegevens over systeemonderhoud, gegevens van elektrische systemen, enz. Hun gegevenstypen, naamgevingsconventies en formaten zijn heel verschillend van gebouw tot gebouw, waardoor het moeilijk is om deze gegevens te gebruiken voor het ontwikkelen van gestandaardiseerde rekenmodellen en algoritmen. Gegevensbronnen of systemen communiceren bovendien met verschillende protocollen en wisselen gegevens uit in verschillende formaten en standaarden. Daarom zijn deze gegevens vaak enkel beschikbaar in silo's – afgezonderde en geïsoleerde omgevingen van data. Ze zijn niet beschikbaar via één platform, waardoor er weinig tot geen interactie of koppeling of gezamenlijk gebruik is van meerderede dergelijke gegevenssilo's. WP4 heeft tot doel methoden te ontwikkelen om deze gegevenssilo's te integreren voor het ontwikkelen van modellen en algoritmen voor *machine learning* en kunstmatige intelligentie, terwijl ook privacy en ethiek worden gegarandeerd bij het verzamelen, opslaan, integreren, delen, beheren of gebruiken van gegevens in slimme gebouwen.

Deze deliverable *"D.4.08 Standardization of data management and integration results (NEN, CEN, ISO)"* rapporteert de status en ontwikkelingen in de wereld van standaarden in het bovenstaande gebied en onderwerp van data integratie voor smart buildings. Dit rapport presenteert de resultaten van de inspanningen van WP4 om relevante standaarden voor databeheer en -integratie in kaart te brengen, te beoordelen en op elkaar af te stemmen. Het verkent het landschap van nationale (NEN), Europese (CEN/CENELEC) en internationale (ISO/IEC) standaarden en biedt richtlijnen over hoe deze standaarden interoperabiliteit, datakwaliteit en ethisch datagebruik in slimme gebouwomgevingen kunnen ondersteunen. Belangrijke technische commissies, relevante standaarden en praktische hulpmiddelen worden geïdentificeerd voor het navigeren door het standaardisatie-ecosysteem. Daarmee wil dit rapport belanghebbenden ondersteunen bij het selecteren en toepassen van de meest geschikte standaarden voor hun data-integratietaken in slimme gebouwen.

SUMMARY

Brains for Buildings' Energy Systems (B4B) is a multi-year, multi-stakeholder project that aims to develop smart building methods to enhance operations in buildings by reducing energy consumption, increasing energy flexibility, increasing occupant comfort, and improving installation maintenance costs. This will be achieved by developing faster and more efficient Machine Learning (ML) and Artificial Intelligence (AI) models and algorithms. The project is geared towards existing utility buildings, such as commercial and institutional buildings.

There are five work packages in this project dedicated to the above tasks. This report is an outcome of Work Package 4 (WP4) of the B4B project, on the theme of "Data integration for Smart Communication". There are many heterogeneous data sources in buildings, e.g., sensor data, 3D model data, time schedules, occupant data, asset maintenance data, electrical system data, etc. Their data types, naming conventions and formats differ, making it difficult to use these data for developing prediction models and AI algorithms. Data sources or systems communicate using different protocols and exchange data in different formats and standards. Therefore, these data are often siloed: they are not available via a single platform, meaning that there is little to no interaction between them. WP4 aims to develop methods to integrate these data silos for developing Machine Learning and Artificial Intelligence models and algorithms while guaranteeing privacy and ethics when collecting, storing, integrating, sharing, managing and/or utilizing data in smart buildings.

This deliverable "*D4.08 Standardization of data management and integration results (NEN, CEN, ISO)*" reports the status and developments in the world of standards for the above introduced area and subject of data integration in smart buildings. It presents the outcomes of WP4's efforts to map, assess, and align relevant standards for data management and integration. It explores the landscape of national (NEN), European (CEN/CENELEC), and international (ISO/IEC) standards, offering guidance on how these standards can support interoperability, data quality, and ethical data use in smart building environments. By identifying key technical committees, relevant standards, and practical tools for navigating the standardization ecosystem, this report aims to support stakeholders in selecting and applying the most appropriate standards for their data integration tasks.

TABLE OF CONTENTS

1 INTRODUCTION

The Brains for Buildings (B4B) project is a multi-year initiative aimed at transforming the energy performance and operational intelligence of existing utility buildings through the application of advanced data-driven technologies. Central to this transformation is the integration of heterogeneous data sources, ranging from sensor outputs and 3D models to maintenance logs and occupant schedules, into coherent, interoperable systems that support the development of Machine Learning (ML) and Artificial Intelligence (AI) models.

Work Package 4 (WP4) of the B4B project focuses on the theme of data integration, addressing the challenges posed by fragmented data ecosystems in smart buildings. These challenges include inconsistent data formats, naming conventions, and communication protocols, which often result in siloed data that is difficult to access, share, or utilize effectively.

This deliverable, D4.08, presents the outcomes of WP4's efforts to map, assess, and align relevant standards for data management and integration. It explores the landscape of national (NEN), European (CEN/CENELEC), and international (ISO/IEC) standards, offering guidance on how these standards can support interoperability, data quality, and ethical data use in smart building environments. By identifying key technical committees, relevant standards, and practical tools for navigating the standardization ecosystem, this report aims to support stakeholders in selecting and applying the most appropriate standards for their data integration tasks.

In this document, an overview is first given of what standards are, how they come about and how they relate to laws and guidelines (Section 2). Section 3 provides an indication of how one can find relevant standards in the different portals of existing standardization organisations. Section 4 finally shows a tabular overview with standards in the Netherlands that are considered relevant for the B4B project. The report ends with a conclusion in Section 5.

2 WHAT IS A STANDARD?

In a smart buildings context, many data formats and systems are at use. They often follow their own internal standards, typically referred to as naming conventions. An important barrier to improved data integration and use in smart buildings is the lack of standards. If more standards were available and were used, then different datasets could be combined more easily, and then also AI techniques and information management and integration approaches would be easier to apply. Hence, there is a clear need for standards in the smart building domain, as well as their active use in practice.

In this Section, we will first go through de definition of a standard (Section 2.1), including what is a standard and what defines a standard versus a regular agreement, for example. Section 2.2 explains who can develop standards, while Section 2.3 indicates where standards can be searched, found, and retrieved.

2.1 Definition of a standard

The baseline of a standard is 'agreement between people', and in the case of B4B also 'agreement between systems'. One of the key indicators in this definition is "how many people" and "how many systems". In principle, an agreement between the members of a small working team, can also be considered a standard, for that particular working team, i.e., a working standard or procedural standard. This easily leads to company standards, or regional standards, or organisation-specific standards: standards that represent the agreement between small groups of people or systems.

The more complicated standards are national standards or even international standards, where the standards are assumed to capture a common agreement between an international group of people (or systems). One example in the building sector is the Industry Foundation Classes (IFC), which represents all the agreed 'foundational classes' of the Architecture, 'Engineering, and Construction (AEC) industry.

In the case of the current Deliverable, standards are more specifically defined as *"widely supported agreements between different parties"*. These agreements are voluntary and can address products, systems, services and processes. The report focuses primarily on national standards for the Netherlands in terms of smart buildings.

For each topic, a considerable number of standards exist. Therefore, this document provides a starting point for one's search for relevant standards. Understanding how standardization works helps find relevant standards.

Standards are developed by international groups of experts through 'standardisation bodies' such as NEN in The Netherlands[1] (*Figure 1*), CEN/CENELEC[2] in Europe, and ISO/IEC[3] globally. There are also standardisation bodies in specific fields or domains of interest, such as the World Wide Web Consortium (W3C)[4] and European Telecommunications Standards Institute (ETSI)[5]. In all these standardisation bodies, experts work together in technical committees (TCs) and working groups (WGs), which are organized by topic. These works follow very structured procedures that have appropriate length and discussion, such that the end result is of high quality and sufficiently supported by the member organisations. Each technical committee manages multiple standards.

[1] https://www.nen.nl/

[2] https://www.cencenelec.eu/

[3] https://www.iso.org/home.html

[4] https://www.w3.org/

[5] https://www.etsi.org/

Figure 1 NEN facilitates standardization for Dutch organizations

Relevant standards can be found either through searching (when you know what you are looking for) or by browsing (better for discovery).

This document outlines a selection of the relevant technical committees (TCs) in the scope of the B4B project (data integration and smart buildings). The TC home pages can be browsed to discover standards which are relevant to any part of the Brains4Buildings project. Also, a selection of relevant standards for the Brains4Buildings project has been made.

2.2 Who creates standards?

In principle, standard agreements can be initiated bottom-up by any set of people (or systems). This typically leads to local standards that help people and systems collaborate and exchange data. In the case of Brains4Buildings, such standards are largely available in the market, and standards with a wider scope and usage are desired, e.g. on national or international level. This needs to happen through a standardisation body (e.g. NEN) and process, such that the correct objective structure and evaluation is followed and maintained.

As mentioned above, such standards are developed by international groups of experts through standardisation bodies such as NEN, CEN/CENELEC and ISO/IEC. Experts work together in technical committees (TCs) and working groups (WGs), which are organized by topic. Each technical committee manages multiple standards.

Standards are developed at 3 levels (*Figure 2*):

1) In The Netherlands at NEN
2) In Europe by CEN and CENELEC
3) Globally by ISO and IEC

Many of the standards in specialized standardisation groups (e.g. W3C, ETSI) are also standardised as a CEN, ISO or other standard.

Figure 2 Standardisation bodies and their level of engagement.

Participation in a European or international standardization effort (CEN, ISO) can be done from within every national standardization body over the world, in which case one acts as the representative of this national standardization body. NEN is the national standardization body for the Netherlands. Each national standards committee within NEN monitors the standardization activities of several international technical committees. Members of the national standardization committee can take part in international working groups that write new standards, revise standards or participate in workshops to elaborate on ‘best practices’. Dutch organizations can participate through NEN, while organizations from other countries can participate through their own national standardisation bodies.

In the case of domain-specific standardization bodies, such as ETSI or W3C, the procedure differs slightly, and these organisations follow their own well-defined structures and procedures to manage and indicate who can and cannot participate in a standardization committee. This often relates to membership.

Roles that can be fulfilled within a national standardisation committee are typically those of chair, secretary, and member. The chair role is performed as a neutral position in the committee allowing to take care that everyone is heard, and consensus is reached between all members of the committee. All other members have the responsibilities of sharing knowledge, participating in discussions, and casting votes on ballots. Roles that are fulfilled within technical committees of CEN, CENELEC and ISO are also that of chairperson for a technical Committee of JTC or being a convenor within a work group. Within ISO, this is called a project manager.

2.3 Legislation and standards

What is the representativeness of a standard? Does it have legal basis, or does it serve as a regular document with guiding principles? What can one expect from a standard?

Governments create laws. In some minority of cases, a law refers to a standard. In most cases, however, and particularly also in the case of most to all smart building-related standards, this is not the case, and the law and standard are two very different documents. In such case, the law describes ‘what’ is required, while the standard can describe the ‘how’: how can an organisation live up to the law? What should it do?

For NEN, the government or governing organisation usually refers to either the government of The Netherlands or the European Union. An example relevant to B4B is the European Energy Performance for Buildings Directive (EPBD). This is a European directive (law) that is implemented in The Netherlands as the “Rijksbouwbesluit”. The accompanying standard is written in the NEN NTA 8800 that is updated on an almost yearly basis by a broad committee covering the different stakeholders.

When a European standard is developed by a recognised European Standards Organisation, namely CEN, CENELEC, or ETSI, it is considered to be a “harmonised standard”[6]. These standards are requested by the European Commission (EC) and guide the development and innovation on the European market. These standards can then be used by any organisation or company to indicate compliance with relevant EU legislation. A full list of harmonised standards is available in the Official Journal of the European Union (OJEU[7]).

[6] https://single-market-economy.ec.europa.eu/single-market/goods/european-standards/harmonised-standards_en

[7] https://eur-lex.europa.eu/oj/direct-access.html

3 HOW TO FIND STANDARDS?

This Section provides a general guide and reference on how to find relevant standards. For each given topic, a considerable number of standards exist. Therefore, the below sections give an indication of how to search standards (Section 3.1), how to browse standards (Section 3.2), and which version one should use (Section 3.3). These are helpful starting points for searching and finding relevant standards. Section 4 will provide a selection of relevant standards for the B4B project scope.

3.1 Searching standards

As one can see in *Figure 3*, finding the relevant standard among the full globally available lists of standards is very similar to finding a specific tree in a series of forests. There are many standards, in multiple versions, that can be found in multiple places. There is also no single reference point that collects *all* standards in existence.

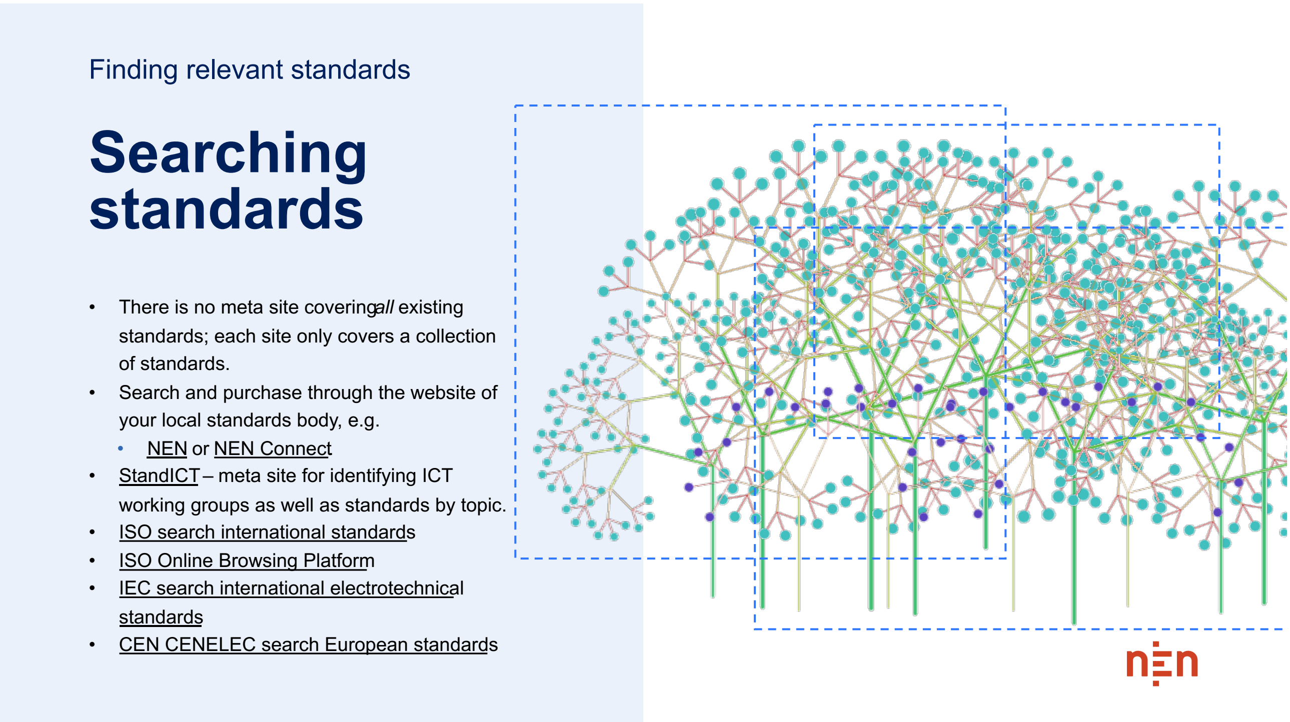

Figure 3 searching standards

A number of starting points are available, however, in the form of search platforms. For the Netherlands, one can find relevant standards in the below platforms:

- NEN Shop[8] – buy individual standards.
- NEN Connect[9] – standards subscription service, giving access to more than 140,000 standards.
- StandICT[10] – standards repository and web platform that provides access to ICT working groups as well as ICT-focused standards, by topic.
- ISO Standards Search Platform[11].
- ISO Online Browsing Platform (OBP)[12].
- IEC International Electrotechnical Commission standards search platform[13].

[8] https://www.nen.nl/norm-kopen
[9] https://connect.nen.nl/
[10] https://www.standict.eu/standards-repository/
[11] https://www.iso.org/advanced-search/x/
[12] https://www.iso.org/obp/ui
[13] https://advsearch.iec.ch

– CEN CENELEC European Standards[14].

The best ways to search for a particular standard in these platforms are either to

1) find it by its numerical ID, e.g. '61970' for 'NEN-EN-IEC 61970-452:2017 en', or
2) find it by keyword search and filters, e.g. 'building information modelling' or 'smart buildings'.

3.2 Browsing standards

If one doesn't know exactly what they're looking for, it helps to browse standards by topic. The structure of information is best revealed through the ISO/CEN technical committee pages[15]. These pages generally list:

1) **Scope** – Read about the topics covered by the technical committee. This helps to quickly identify the relevance of the standards developed by this 'TC'.
2) **Structure** – Find out into which subcommittees and working groups the technical committee is subdivided.
3) **Published standards** – Discover on which topics standards have already been published.
4) **Standards under development** – Discover on which standards experts are currently working.

The best strategy is to first assess the relevance of technical committees by reading their scope. Then, narrow down by browsing titles of publications and reading abstracts and previews of specific standards (see *Figure 4*).

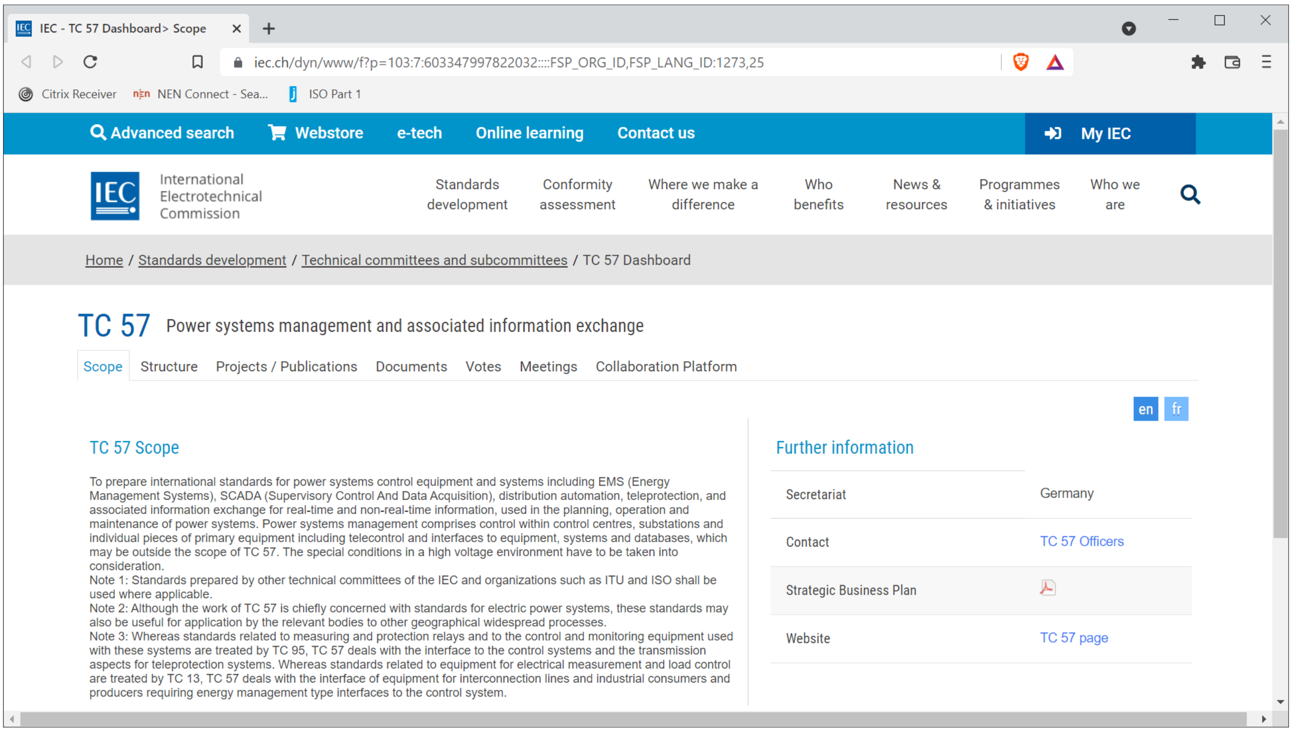

Figure 4 Browsing technical committee home pages

3.3 Which version to use?

Once the correct or relevant standard is found, the correct version needs to be selected and retrieved as well. As an example, *Figure 5* shows an image of a specific standard found in NEN Connect. This page gives an overview of current versions of a specific standard. The annotations in the naming of these versions give an indication of which version one is dealing with. For example, the name includes 'NEN', 'EN', 'ISO', ID number, symbols (-), year numbers, and 'en', 'nl', and other.

14 https://standards.cencenelec.eu

15 https://standards.cencenelec.eu/ords/f?p=CEN:6

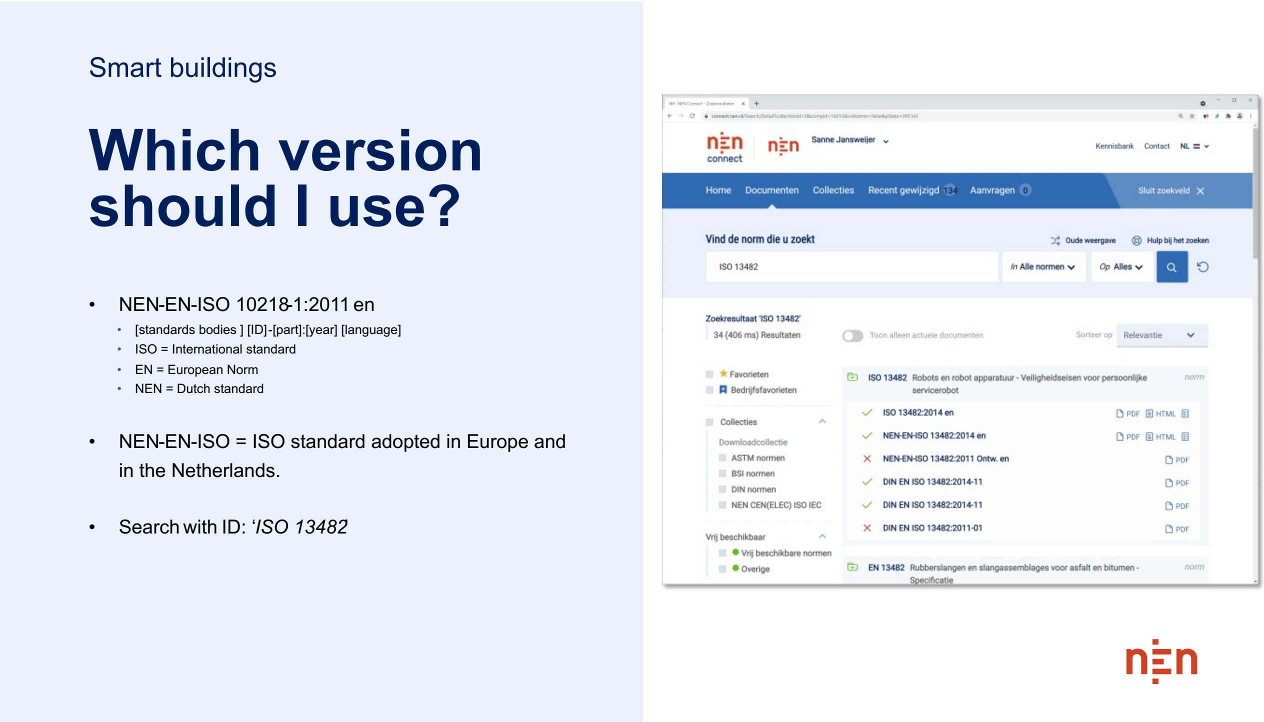

Figure 5 How to find the right version of a standard

The first part of the standard name defines the standardisation body that has released the standard:

- ISO denotes an international standard by ISO;
- EN denotes European Norm;
- NEN means Dutch standard;
- Other acronyms like DIN refer to other national standardisation bodies (e.g., German).

Combinations are also possible. So NEN-EN-ISO means an ISO standard which was adopted in Europe as well as in the Netherlands. The content of the standard is generally the same.

The second part of the name indicates the standard identification number, while the last part refers to the language of the standard, e.g. Dutch ('nl') as well as English ('en').

4 STANDARDS RELEVANT FOR SMART BUILDINGS AND DATA INTEGRATION

This Section presents a selected list of standards that have been searched during the B4B project and that are considered relevant for the B4B project stakeholders. These standards are organized by specific topics and their corresponding technical committees where applicable. This structure covers:

– smart buildings,
– information technologies,
– real estate,
– systems, and
– smart cities.

Many of the topics in the considered standards are in the field of “Data Exchange” and “Data Integration”, since this is also the focus point of the WP4, but also because standards often cover data formats and naming conventions in relation to data use. Also, in accordance with the European Data Act[16], one can see that a lot of focus from many committees is towards data exchange, data integration and data sharing.

Another subject, relevant to the B4B scope, that has the attention of many committees is that of “Smart Energy”. With this focus, standardisation committees aim to accommodate the climate goals of European member states and their technical committees. These TCs are working on standards that help achieve these goals.

In Sections 4.1 to 4.5, the mentioned topics will be addressed, including the most prevailing standards on those topics. In Appendix I, all links to the European and international technical committees can be found, ordered by work package (Table 6), as well as a list of standardisation committees with their titles (

16 https://eur-lex.europa.eu/eli/reg/2023/2854

Table 7).

4.1 Smart Buildings

The main standards on the topic of smart buildings can be found in Table 1. In this topic, we can distinguish between standards on:

– Building Automation, Controls and Building Management (BACS), and
– Home and Building Electronic Systems (HBES).

Table 1 - Relevant standards on the topic 'Smart Buildings'.

Smart buildings
Building Automation, Controls and Building Management (BACS)
'BACS' stands for 'Building Automation and Control System', also known as Building Management Systems. These systems focus on the functionality required for efficient technical management of buildings. They are part of the technological infrastructure needed for smart buildings – refer to Deliverable D 4.04. Smart Building Assessment. This technical committee works on standards regarding the functionality of BACS, open data communication, and BACS energy performance. Technical Committee: CEN/TC 247 Standards: - NEN-EN-ISO 52127 series: Energy performance of buildings – Building management system - NEN-EN-ISO 16484 series: Building automation and control systems (BACS)
Home and Building Electronic Systems (HBES)
In smart buildings, human comfort is optimized using technology. A European series of standards ensures interoperability between energy management systems, smart meters, and smart grids. These standards cover a broad spectrum of control applications, with attention to Electromagnetic Compatibility (EMC) and electrical and functional safety. The focus is on performance requirements and the necessary interfaces for hardware and software, with increasing attention to cybersecurity and energy management in buildings. Technical Committee: CLC/TC 205 Standards: - NEN-EN 50090-series: Building Management systems, HBES - NEN-EN 50491-series: General requirements for electronic systems in homes and building automation and control systems - CLC/TS 50560: Interoperability framework requirement specification

4.2 Information Technologies

A second set of standards is available on the topic of Information Technologies (IT). The relevant list of standardisation committees and standards is available in Table 2. In this topic, we can distinguish between standards on:

– Software and systems engineering,
– Interconnection of information technology equipment,
– Information security, cybersecurity and privacy protection - Cybersecurity and Data Protection, and
– Telecommunications and information exchange between systems.

Table 2 - Relevant standards on the topic 'Information Technologies'.

Information Technologies
Software and systems engineering
Standards for software and systems engineering focus on the requirements and best practices for developing and maintaining high-quality software and systems. Software is integral to nearly all products, from laptops and consumer electronics to vehicles, buildings, and industrial machines. As software complexity grows, developing and maintaining customized software requires considering customer needs, various constraints, and conditions. This field necessitates extensive expertise and attention. The standards aim to provide a structured approach, methodologies, and procedures, along with supporting tools and technologies, to ensure effective software and systems engineering. Technical Committee: ISO/IEC JTC 1/SC 7 Standards:

Information Technologies
- NEN-ISO/IEC 19770 series: Information technology – IT asset management
Interconnection of information technology equipment
These standards focus on microprocessor systems, interfaces, protocols, and architectures for IT equipment and networks, supporting embedded and distributed computing, storage systems, and input/output components. They also cover home and building electronic systems in residential and commercial settings, enabling IoT device interworking and applications like energy management, environmental control, lighting, and security. Technical Committee: ISO/IEC JTC 1/SC 25 Standards: - NEN-ISO/IEC 15067 series: Information technology – Home Electronic System (HES) application model - NEN-ISO/IEC 14543 series: Information technology – Home Electronic System (HES) architecture - NPR-ISO/IEC TR 29108: Information technology – Terminology for intelligent homes - NPR-ISO/IEC TR 29107-1: Information technology – Intelligent homes – Taxonomy of specifications – Part 1: Taxonomy method
Information security, cybersecurity and privacy protection --- Cybersecurity and Data Protection
The standards for cybersecurity and privacy focus on protecting information and ICT through comprehensive methods, techniques, and guidelines. They address security requirements, information and ICT security management, and cryptographic mechanisms to ensure data integrity, confidentiality, and availability. Additionally, they provide support documentation for security management, covering terminology, guidelines, and registration procedures for security components. Technical Committee: ISO/IEC JTC 1/SC 27, CEN/CLC/JTC 13 Standards: - NEN-EN-ISO/IEC 27000: Information Security Management Systems – Overview and definitions - NEN-EN-ISO/IEC 27001: Information Security Management Systems - Requirements - NEN-EN-ISO/IEC 27002: Practical guideline with management measures in the field of information security - NEN-ISO/IEC 27014: Information security, cybersecurity and privacy protection – Governance of information security - NEN-ISO/IEC 27032: Information technology – Security techniques – Guidelines for cybersecurity - IEC 62443 series: cybersecurity for operational technology in automation and control systems
Telecommunications and information exchange between systems
The standards for IT Service Management and IT governance provide frameworks for managing IT projects, ensuring accountability, and overseeing service landscapes, promoting responsible data management and efficient IT resource use. Additionally, they create an interoperability framework for architectures and systems, focusing on telecommunications and information exchange, and standardizing techniques for ICT applications and services. The process involves reviewing proposals, ratifying standards, and supporting their application and maintenance, helping organisations align IT governance with business goals and regulations. Technical Committee: ISO/IEC JTC 1/WG 6 Standards: - NEN-ISO/IEC 38500: Information technology – Governance of IT for the organisation - NPR-ISO/IEC TS 38501: Information technology – Governance of IT – Implementation guide

4.3 Real Estate

Standards are also available on the topic of real estate. These technical committees and their standards are given in Table 3. Areas covered by these technical committees and standards are:

- Asset Management,
- Policy-based framework for building management in the built environment,
- Sustainability of buildings,
- Condition Assessment,
- Information Modelling & Management, and
- Facility Management.

Table 3 - Relevant standards on the topic 'Real Estate'.

Real estate
Asset Management

Real estate
Asset management standards offer guidelines for effectively managing an organisation's resources. They outline how to track, maintain, and optimize assets to maximize their value and lifespan. These frameworks help organisations of all sizes make better decisions about their assets, whether they are physical equipment, digital systems, or other valuable resources. The standards emphasize setting clear goals, measuring results, and continually improving asset management practices. By following these principles, companies can better align their asset use with their overall business objectives, potentially reducing cost and improving performance. Technical Committee: ISO/PC 251 Standards: - NEN-ISO 55000: Asset management – Overview, principles and terminology - NEN-ISO 55001: Asset management – Management systems - Requirements - NEN-ISO 55002: Asset management – Management systems – Guidelines on the application of ISO 55001
Policy-based framework for building management in the built environment
This standard provides a method of for organisations to manage assets in the built environment using a risk-based approach. It allows organisations to align asset management with their ambitions and core values. The standard promotes continuous feedback between tactical, strategic, and operational levels, helping organisations maintain uniform, objective, and demonstrable control over all their assets, including both infrastructure and real estate. Technical Committee: CEN/TC 319/WG 11 Standards: - NEN 8026:2023 nl: Method for Value-Driven Maintenance of Assets in the Built Environment
Sustainability of Buildings
This standard provides specific methods and requirements for the assessment of social performance of a building while taking into account the building's functionality and characteristics. The standard applies to all types of buildings, both new and existing. In this first version of the standard, the social dimension of sustainability concentrates on the assessment of aspects and impacts for the use of a building expressed using the following social performance categories: accessibility, adaptability, health and comfort, impact on the neighbourhood, maintenance, safety and security. Technical Committee: CEN/TC 350 Standards: - NEN-EN 16309: Sustainability of Buildings – Assessment of the Social performance of Buildings – Calculation Methods
Condition assessment
This standard provides a method for objectively assessing the technical condition of building components based on observed defects during inspections. It is widely used for evaluating the condition of the built environments. Technical Committee: CEN/TC 319/WG 11 Standards: - NEN 2767-1+C1:2019 nl: Condition Assessment of the Built Environment – Part 1 Methodology
Information modelling & management
This standard provides a framework for developing coherent conceptual models related to the use and entire lifecycle of the built environment and its elements. These standards are highly relevant in the context of Building Information Modelling and Asset Management. Technical Committee: N.A. Standards: - NEN 2660-1:2022 nl: Rules for Information Modelling of the Built Environment – Part 1: Conceptual Models - NEN 2660-2:2022 nl: Rules for information modelling of the built environment – Part 2: practical configuration, extension, and implementation of Part 1 - EN 17632 part 1-2: Building Information Modelling (BIM) - Semantic Modelling and Linking (SML) - ISO 19650-1 t/m 5: Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM). Information management using building information modelling.
Facility Management
These standards provide methods for evaluating and managing buildings and facilities. One offers a quick assessment tool for comparing building performance against user needs and between different properties, applicable to organisations of all sizes. The other outlines requirements for facility management systems, focusing on effective delivery, meeting stakeholder needs, and sustainability in a competitive environment.

Real estate
Technical Committee; CEN/TC 348 Standards: - NEN 8021:2014 nl: Evaluation of the Functional Performance of Utility Buildings - NEN-EN-ISO 41001:2018 nl: Facility management – Management Systems – Requirements with Guidelines for Use - NEN 2580: Areas and Volumes of buildings – Terms, Definitions, and Determination Methods - NEN-EN 15221: Facility Management – Part 4: Taxonomy, Classification, and Structures in Facility Management

4.4 Systems

Standards and technical committees have also been found in relation to the standardisation of systems. These technical committees and standards can be found in Table 4. Again, a number of subcategories have been identified:

- Electrical accessories,
- Thermal performance and energy use in the built environment,
- Indoor Climate and Energy Performance,
- Alarm Systems - Services for fire safety and security systems,
- Fire detection and fire alarm systems.

Table 4 - Relevant standards on the topic 'Systems'.

Systems
Electrical accessories
Standards for Home and Building Electronic Systems (HBES) and Building Automation and Control Systems (BACS) focus on ensuring safety, EMC, performance, compatibility, and interoperability for systems that automate and control building functions. These standards apply to both AC and DC systems in households and similar environments, such as offices, commercial premises, hospitals, and public buildings. They cover the integration of electronic components, software, digital interfaces, and energy management, enhancing efficiency and enabling seamless connectivity with smart grids and building automation networks. Technical Committee: IEC/TC 23 Standards: - NEN-EN-IEC 63044 series: Building management systems and systems for building automation and control systems
Thermal performance and energy use in the built environment
The standards for energy performance of buildings (EPB) focus on establishing a systemic, comprehensive, and modular structure for assessing the energy performance of both new and existing buildings. These standards provide methods for evaluating and improving building energy efficiency, covering the assessment of overall energy use through measurement or calculation, and calculating energy performance in terms of primary energy or other energy related metrics. They address various applications, including building design, new buildings 'as built', existing buildings in use, and renovation, ensuring a holistic approach to building energy performance. Technical Committee: ISO/TC 163, CEN/TC 371 Standards: - NEN-EN-ISO 52000 series: Energy performance of buildings – Overarching provisions of EPB
Indoor climate and energy performance
The standards for indoor climate and building energy performance focus on standardization related to creating comfortable and energy-efficient indoor environments. These standards cover the determination of energy performance for buildings and address various aspects of indoor climate, including installations for heating, cooling, moisture control, infiltration, air treatment, and ventilation. They ensure that these elements contribute to the overall energy performance at the building level. By setting these standards, the aim is to optimize indoor conditions for health and comfort while maximizing energy efficiency. Product-specific standards are not included within this scope. Technical Committee: NC 351074 Standards: - NTA 8800: Energy performance of buildings – A determination method - NEN 1087: Ventilation and air treatment in buildings - NEN 1891: Light and lighting – Measuring lighting performance

Systems
- NEN-EN 12464-1: Light and lighting – Workplace lighting – Part 1: Indoor workplaces - NEN-Spec 2:2020: Office workplaces – Ergonomic requirements for layout and design in the context of COVID-19 measures
Alarm Systems – Project Committee – Services for fire safety and security systems
Alarm systems detect intrusions, hold-ups, and serve as security and evacuation systems, including social alarms. Unlike other electronics, they must function reliably in all conditions. The national standards committee for alarm systems sets Dutch positions on European and global standards. These standards cover detection, alarm, and monitoring systems to protect people and property, including intrusion alarms, access control, video surveillance, alarm transmission, and combined security and other security-related monitoring and surveillance systems. Technical Committee: IEC/TC 79, CLC/TC 79, CEN/CLC/JTC 4 Standards: - NEN-EN 50131-series: Alarm Systems – Burglary and Robbery Systems - NEN-EN 50398-series: Alarm Systems – Combined and Integrated Alarm Systems - NEN-EN 50486: Equipment for Use in Audio and Video Intercom Systems - NPR-CLC/TR 50531: Alarm Systems – Terms and Definitions - IEC 60839 series: Alarm Installations - IEC 62642 series: Alarm Systems – Burglary and Robbery Alarm Systems
Fire detection and fire alarm systems
The standards define requirements and guidelines for fire detection and evacuation alarm systems used in and around buildings and structures. With a focus on fire alarm systems, evacuation alarms, and smoke detectors, including standards for their maintenance and the functionality of transmission paths during a fire. Technical Committee: CEN/TC 72, ISO/TC 21/SC 3 Standards: - NEN 2575 series: Fire safety of buildings – Evacuation alarm systems – System and quality requirements and project guidelines

4.5 Smart Cities

A last set of standards that is included in this report, includes the standards created by technical committees on the topic of Smart Cities. These standards can be found in Table 5. In this case, they focus on the area of Sustainable Cities and Communities.

Table 5 - Relevant standards on the topic 'Smart Cities'.

Smart Cities
Sustainable cities and communities
Standardization in the field of Sustainable Cities and Communities involves developing requirements, frameworks, guidance, and supporting techniques and tools to achieve sustainable development. These efforts provide a foundation for cities and communities, both rural and urban, to become more sustainable. By offering a descriptive framework and clear vocabulary, these standards help cities, and their stakeholders implement sustainable practices effectively, fostering environments that are adaptable, efficient and resilient to future challenges. Technical Committee: ISO/TC 268 Standards: - NPR 8284: Open urban platform - NEN-ISO 37100: Sustainable cities and communities – Vocabulary - NEN-ISO 37105: Sustainable cities and communities – Descriptive framework for cities and communities

5 CONCLUSION

The Brains for Buildings' Energy Systems (B4B) project recognizes that the future of smart, energy-efficient buildings depends on the seamless integration and management of diverse data sources. This deliverable, D4.08, has explored the landscape of standards that underpin data interoperability, privacy, and system integration within the built environment, particularly for the field of smart buildings and systems.

A mapping of relevant national (NEN), European (CEN/CENELEC), and international (ISO/IEC) standards is provided, and as such, this report provides a reference for stakeholders that aim to increase standardisation in their building systems as well as the data use in their buildings and systems, e.g. in the context of Building Information Modelling, data analysis, and asset management. Also, an overview is given of what standards are, where one can find these, and how to use standards. The report highlights the importance of technical committees, the role of harmonized standards in regulatory compliance, and the need for practical tools to support data engineers and system integrators in selecting appropriate standards.

Despite the breadth of existing standards, challenges remain in identifying which standards are most applicable to specific datasets or use cases. This underscores the need for clearer guidance, e.g., such as decision trees or flow diagrams, to support practical implementation.

As the B4B project progresses, continued collaboration with standardization bodies and active participation in technical committees is important to ensure that the evolving needs of smart buildings are reflected in future standards. By fostering a standardized, interoperable data ecosystem, B4B aims to accelerate the deployment of intelligent, sustainable, and user-centric building technologies.

REFERENCES

NEN shop – buy individual standards: https://www.nen.nl/norm-kopen

NEN Connect – standards subscription service: https://connect.nen.nl/

StandICT – meta site for identifying ICT working groups as well as standards by topic: https://www.standict.eu/standards-repository/

ISO search international standards: https://www.iso.org/advanced-search/x/

ISO Online Browsing Platform: https://www.iso.org/obp/ui

IEC search international electrotechnical standards:

https://advsearch.iec.ch/ords/f?p=117:105:12654817582579::::FSP_LANG_ID:25

CEN CENELEC search European standards: https://standards.cencenelec.eu/dyn/www/f?p=CEN:105:0:RESET::::

NTA 8035:2020 nl Semantische gegevensmodellering in de gebouwde omgeving.

https://www.nen.nl/nta-8035-2020-nl-266070

NEN 2660-2:2021 Ontw. Nl Regels voor informatiemodellering van de gebouwde omgeving - Deel 2: Praktische configuratie, extensie en implementatie van deel 1

https://www.nen.nl/nen-2660-2-2021-ontw-nl-279908

APPENDIX 1 - KEY TECHNICAL COMMITTEES

Table 6 - Relevant technical committees per work package.

Technical Committee (TC)	Committee title	WP1 Self-diagnosing installations	WP2 Energy flexibility	WP3 User centric interfaces and feedback	WP4 Data integration	WP5 Learning communities
CEN/TC 247	Building Automation, Controls and Building Management					
ISO/TC 205	Building environment design					
CEN/TC 442	Building Information Modelling (BIM)					
ISO/TC 59	Buildings and civil engineering works					
ISO/TC 22/SC 31	Data communication					
ISO/IEC JTC 1/SC 32	Data management and interchange					
ISO/TC 232	Education and learning services					
IEC/TC 23	Electrical accessories					
CEN/CLC/JTC 14	Energy management and energy efficiency in the framework of energy transition					
ISO/TC 301	Energy management and energy savings					
CEN/TC 371/WG 1	EPBD Standards group					
ISO/TC 159/SC 4	Ergonomics of human-system interaction					
CLC/TC 205	Home and Building Electronic Systems (HBES)					
ISO/IEC JTC 1/SC 27	Information security, cybersecurity and privacy protection					
ISO/IEC JTC 1	Information technology					
ISO/IEC JTC 1/SC 36	Information technology for learning, education and training					
ISO/IEC JTC 1/SC 25	Interconnection of information technology equipment					
ISO/IEC JTC 1/SC 41	Internet of Things and Digital Twin					
IEC/TC 57	Power systems management and associated information exchange					
CEN/TC 156	Ventilation for buildings					

Table 7 - Other relevant technical committees.

Technical Committee (TC)	Committee title
ASTM D22	Air Quality
IEC/TC 79	Alarm and electronic security systems
CLC/TC 79	Alarm systems
ISO/IEC JTC 1/SC 29	Coding of audio, picture, multimedia and hypermedia information
ISO/TC 215/WG 2	Data interchange
ISO/TC 215/WG 1	Data structure
IEC/SC 65E	Devices and integration in enterprise systems
CLC/TC 215	Electrotechnical aspects of telecommunication equipment
IEC/TC 86	Fibre optics
IEC/SC 86A	Fibres and cables
ISO/TC 21/SC 3	Fire detection and alarm systems
CEN/TC 72/WG 3	Fire detection and fire alarm systems
ISO/TC 211	Geographic information/Geomatics
CEN/TC 228	Heating systems and water based cooling systems in buildings
ASTM E54	Homeland Security Applications
ISO/IEC JTC 1/SC 27/WG 5	Identity management and privacy technologies
ISO/TC 184/SC 4	Industrial data
CLC/TC 65X	Industrial-process measurement, control and automation
IEC/TC 65	Industrial-process measurement, control and automation
ISO/IEC JTC 1/SC 27/WG 1	Information security management systems
ISO/TC 204	Intelligent transport systems
ISO/TC 37/SC 4	Language and terminology
IEC/TC 45	Nuclear instrumentation
ISO/TC 59/SC 13	Organization of information about construction works
ASTM E06	Performance of Buildings
CEN/CLC/JTC 4/WG 1	Services for fire safety and security systems
ISO/TC 268/SC 1	Smart community infrastructures
ISO/IEC JTC 1/SC 7	Software and systems engineering
IEC/TC 82	Solar photovoltaic energy systems
ASTM E44	Solar, Geothermal and Other Alternative Energy Sources
CEN/TC 130	Space heating and/or cooling appliances without integral thermal sources
IEC/TC 121	Switchgear and controlgear and their assemblies for low voltage
CEN/TC 348	Facility Management
ISO/TC 163	Thermal performance and energy use in the built environment
ISO/TC 163/SC 1	Test and measurement methods
ISO/IEC JTC 1/SC 6	Telecommunications and information exchange between systems
ISO/TC 86/SC 6	Testing and rating of air-conditioners and heat pumps
ASTM C16	Thermal Insulation