H2020 - EEB - 2017 - 766464 – SCORES

Self Consumption Of Renewable Energy by hybrid Storage systems

D2.6 Report on legislation and standardization issues

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1 Background

The SCORES project aim is to develop and demonstrate in the field a building energy system, including new compact hybrid storage technologies, optimizes supply, storage and demand of electricity and heat in residential buildings, increasing self-consumption of local renewable energy in residential buildings at the lowest cost. Combination and optimization of multi-energy generation, storage, and consumption of local renewable energy (electricity and heat) brings new sources of flexibility to the grid and giving options for tradability and economic benefits, enabling reliable operation with a positive business case in Europe building stock. SCORES optimizes self-consumption of renewable energy and defers investments in the energy grid.

This deliverable D2.5 reports the outcome of the work developed in Task 2.5, that analyses and assesses the current legislative framework for the proposed hybrid system, identifies the gap in legislation, and addresses policy aspects.

This document was compiled by RINA, whereas different partners within the SCORES program have shared their expertise for this document. The document has also been reviewed by the partners within the SCORES program before publication.

2 References

2.1 Applicable Documents

	Document	Reference	Issue
AD-01	SCORES Grant Agreement	No. 766464	
AD-02	SCORES Consortium Agreement	No. 0100308813	

2.2 RD-13Reference Documents

	Document	Reference	Issue
RD-01	Proposal for a DECISION on a General Union Environment Action Programme to 2030	https://ec.europa.eu/environment/pdf/8EAP/2020/10/8EAP-draft.pdf	
RD-02	REGULATION (EU) 2018/1999 of 11 December 2018 on the Governance of the Energy Union and Climate Action	http://data.europa.eu/eli/reg/2018/1999/oj	
RD-03	DIRECTIVE 2010/31/EU of 19 May 2010 on the energy performance of buildings	https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32010L0031	
RD-04	DIRECTIVE 2009/28/EC of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC	https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0028&from=EN	
RD-05	DIRECTIVE (EU) 2018/844 of 30 May 2018 amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency	https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L0844	
RD-06	COMMISSION RECOMMENDATION (EU) 2019/1019 of 7 June 2019 on building modernization	https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019H1019	
RD-07	REGULATION (EU) 2017/1369 of 4 July 2017setting a framework for energy labelling and repealing Directive 2010/30/EU	https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32017R1369	
RD-08	Hans Erhorn, Heike Erhorn-Kluttig, New buildings & NZEBs,Concerted Action EPBD, 2018	https://epbd-ca.eu/wp-content/uploads/2019/09/CA-EPBD-CT1-New-buildings-NZEBs-2018.pdf	
RD-09	COMMISSION RECOMMENDATION (EU) 2016/1318 of 29 July 2016	https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016H1318&from=EN	
RD-10	Erhorn-Kluttig, H.; Erhorn, H.: National Applications of the NZEB Definition – The	http://www.epbd-ca.eu/outcomes/2011-	

	complete Overview. Status February 2018. Factsheet of the Concerted Action EPBD, 2018.	2015/CA3-CT-2015-5-Towards-2020-NZEB-web.pdf	
RD-11	Kirsten Engelund Thomsen, Kim B. Wittchen, Energy performance requirements using Cost-Optimal Level Concerted Action EPBD, 2018.	https://www.epbd-ca.eu/outcomes/2011-2015/CA3-CT-2015-4-Cost-optimal-levels-web.pdf	
RD-12	Directive (EU) 2019/944 of the European Parliament and of the Council of 5 June 2019 on common rules for the internal market for electricity and amending Directive 2012/27/EU	http://data.europa.eu/eli/dir/2019/944/oj	
RD-13	Directive 2012/27/EU of the European Parliament and of the council of 25 October 2012 on energy efficiency	https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32012L0027&from=IT	
RD-14	Directive EU 2018/2002 of the European Parliament and of the council of 11 December 2018 that amend the Directive 2012/27/EU on energy efficiency	https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L2002&from=EN	
RD-15	Strepin 2020		
RD-16	EnR Position Paper on Energy Poverty in the European Union - January 2019	https://enr-network.org/wp-content/uploads/ENERGYPOVERTY-EnRPositionPaper-Energypoverty-Jan-2019.pdf	
RD-17	Member state report Germany	https://www.energypoverty.eu/observatory-documents/germany	
RD-18	Green Deal 2019	https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en	
RD-19	European Strategic Energy Technology Plan- 2014	https://ec.europa.eu/energy/topics/technology-and-innovation/strategic-energy-technology-plan_en	
RD-20	NextGenerationEU- Recovery Plan	https://ec.europa.eu/info/strategy/recovery-plan-europe_en	
RD-21	RES Legal- Legal Sources On Renewable Energy	http://www.res-legal.eu/en/home/	
RD-22	EN ISO 52000-1:2017 Energy performance of buildings – Overarching EPB assessment – Part 1: general framework and procedures		
RD-23	IEC 62619 Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for		

	secondary lithium cells and batteries, for use in industrial applications		
RD-24	IEC 63056 Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for secondary lithium cells and batteries for use in electrical energy storage systems		
RD-25	Strategic Action Plan on Batteries- 2018	https://ec.europa.eu/transport/sites/transport/files/3rd-mobility-pack/com20180293-annex2_en.pdf	
RD-26	*European Battery Alliance*- 2017	https://ec.europa.eu/growth/industry/policy/european-battery-alliance_en	
RD-27	Clean Energy for All Europeans- 2016	https://ec.europa.eu/energy/topics/energy-strategy/clean-energy-all-europeans_en	
RD-28	Directive of the European Parliament and of the Council on common rules for the internal market in electricity- 2019	https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CONSIL:ST_5076_2019_INIT&from=EN	
RD-29	Common rules for the internal electricity market- 2009	https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32009L0072&from=IT	
RD-30	IEC 62620 Secondary cells and batteries containing alkaline or other non-acid electrolytes - Secondary lithium cells and batteries for use in industrial applications		
RD-31	IEC 61427-1 Secondary cells and batteries for renewable energy storage - General requirements and methods of test - Part 1: Photovoltaic off-grid application		
RD-32	IEC 61427-2 Secondary cells and batteries for renewable energy storage - General requirements and methods of test - Part 2: On-grid applications		
RD-33	IEC 62281 Safety of primary and secondary lithium cells and batteries during transport		
RD-34	Smart Readiness Indicator for Buildings	https://smartreadinessindicator.eu/	

3 Terms, definitions and abbreviated terms

BEMS	Building Energy Management System
EAP	Environmental Action Programme
EED	Energy Efficiency Directive
EPBD	Energy Performance Buildings Directive
MS	Member State
RED	Renewable Energy Directive

4 Executive summary

This deliverable is focused on the current legislative framework of reference for the SCORES hybrid energy system, with the aim of **identifying eventual gaps in legislation**, therefore addressing policy aspect by **developing policy recommendations** aimed at stimulating take up of hybrid system solutions by the market.

The hybrid systems involved in this project are very innovative, and there is a risk that their development can be slowed down by lack in legislation and standard.

A survey of existing standard was developed on hydrogen equipment, second life Li-Ion batteries, and Building Energy Management Systems, with a focus on the stationary application in residential and tertiary buildings.

The results of the analysis led to the identification of specific gaps that could delay the development of hybrid systems in European buildings.

5 Analysis of existing and ongoing implementation of EU legislation

The aim of this section is to analyse the main pillars of the policy framework related to hybrid energy systems at EU, national and local level.

The first step deals with an overview of the global framework of European policy:

- The 8th Environment Action Programme (EAP) in draft
- Energy and Climate Regulation (Regulation EU 2018/1999)

Followed by a focus on the main three European directives focused on the decarbonization of buildings:

- EPBD, Energy Performance Buildings Directive (2018/844/EU, as amendment of 2010/31/EU))
- RED Renewable Energy Directive (2009/28/EC)
- EED Energy Efficiency Directive (2012/27/EU, amended by Directive 2018/2002/EU)

Other crucial aspect is the relation of the buildings with electric market, that will be one of the most important drivers for the evolution of HVAC and electric systems in the buildings in the coming future.

- Directive 2019/994 on internal market for electricity

5.1 8th Environment Action Programme

Since the mid-1970s, EU environment policy has been guided by action programmes defining priority objectives to be achieved over periods of years. On 14 October 2020 the European Commission published a proposal for an 8th Environmental Action Programme (RD-01) to replace the 7th that will be expired on 31 December 2020.

One of the purposes of this Programme is to create common ownership of all three EU institutions and the Member States of its objectives, providing policymakers and other stakeholders - including regions and cities, businesses, social partners, civil society organizations and individual citizens - with a predictable framework and direction for action.

On 11 December 2019, the European Commission adopted of the **European Green Deal**, an ambitious agenda for the EU to become the **first climate neutral continent by 2050** and to protect, conserve and enhance the EU's natural capital, and protect the health and well-being of citizens from environmental risks and impacts.

The Commission proposed to enshrine its long-term strategy in the **European Climate Law** and also adopted a number of new strategic initiatives:

- **Circular Economy Action Plan** for a clean and competitive Europe,
- **Biodiversity Strategy** for 2030
- **Farm to Fork Strategy**

The EU has also adopted a comprehensive response to the coronavirus crisis, which is causing a heavy toll on life and livelihoods and has led to unprecedented challenges to policymaking, aggravated by a severe economic downturn.

The **Next Generation EU Recovery Plan** proposed by the European Commission on 27 May 2020 and endorsed by the Extraordinary European Council of July 2020 highlights the status of the European Green Deal as Europe's new growth strategy and its role in achieving a sustainable and rapid recovery as well as ensuring long term predictability on the path to climate neutrality, and ultimately a just and fair transition, which leaves no-one behind.

The 8th Environment Action Programme, with its long-term vision and environmental priority objectives shared with the Green Deal, will support the EU's common commitment to a green recovery and the reduction of pressures on the environment and the climate and strengthening the integrated approach to policy development and implementation, notably by main streaming sustainability in all relevant initiatives and projects at national and EU level.

The 8th EAP has the following six thematic priority objectives:

(a) irreversible and gradual reduction of greenhouse gas emissions and enhancement of removals by natural and other sinks in the Union to attain the 2030 greenhouse gas emission reduction target and achieve climate neutrality by 2050;
(b) continuous progress in enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change;
(c) advancing towards a regenerative growth model that gives back to the planet more than it takes, decoupling economic growth from resource use and environmental degradation, and accelerating the transition to a circular economy;
(d) pursuing a zero-pollution ambition for a toxic free-environment, including for air, water and soil, and protecting the health and well-being of citizens from environment-related risks and impacts;
(e) protecting, preserving and restoring biodiversity and enhancing natural capital, notably air, water, soil, and forest, freshwater, wetland and marine ecosystems;
(f) promoting environmental sustainability and reducing key environmental and climate pressures related to production and consumption, in particular in the areas of energy, industrial development, buildings and infrastructure, mobility and the food system.

5.2 Governance of Energy and Climate Actions in EU

The REGULATION (EU) 2018/1999 of 11 December 2018 on the Governance of the Energy Union and Climate Action (RD-02) sets out the necessary legislative foundation for reliable, inclusive, cost-efficient, transparent, and predictable governance of the Energy Union and Climate Action (governance mechanism), which ensures the achievement of the 2030 and long-term objectives and targets of the Energy Union.

The Energy Union policy has been schematized in five dimensions:

- energy security
- internal energy market
- energy efficiency
- decarbonization
- research, innovation, and competitiveness

Parallel to this Regulation, the Commission has developed and adopted a series of initiatives in sectoral energy policy, in particular regarding:

- renewable energy
- energy efficiency
- energy performance of buildings
- market design
- energy poverty

Those initiatives form a package under the overarching theme of energy efficiency first, the Union's global leadership in renewables, and a fair deal for energy consumers, including by addressing energy poverty and promoting fair competition in the internal market.

After the 20-20-20 objectives, the commitment for the European Union is to achieve by 2030 compared with 1990:

- a reduction of 40% greenhouse gas emissions
- an increase of 32.5% saving thanks to energy efficiency
- an increase of 32% of energy produced from renewable source.

This regulation also introduces the **Energy and Climate Plans**, drafted by each Member State, to guarantee a coordinate and integrate policy over all the Energy Union's five dimensions and supply in one document, all the data required to monitoring the goals pursuing.

5.3 Energy Performance Buildings Directive 2010 (EPBD) – Nearly Zero Energy Building

In December 2002, the first version of the Energy Performance Building Directive (EPBD) 2002/91/EC was approved. EU Member States had to comply with the Directive within three years of the inception date (4 January 2006), by bringing into force necessary laws, regulations, and administrative provisions.

The EPBD required that the Member States strengthen their building regulations and introduce:

- energy performance certification of buildings
- inspection of boilers and air conditioning systems

In May 2010, the first version of EPBD was replaced by Directive 2010/31/EC (RD-03). This recast presented a new important challenge, as far as new buildings are concerned, the realization of **Nearly Zero-Energy Buildings (NZEB)** by 2021 (or, in the case of public buildings by 2019).

A NZEB is defined in Article 2(2) of the EPBD as "*a building that has a very high energy performance, as determined in accordance with Annex I. The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby*".

Further clarification about NZEB definition and new guidelines was drafted by European commission with COMMISSION RECOMMENDATION (EU) 2016/1318 of 29 July 2016 (RD-09).

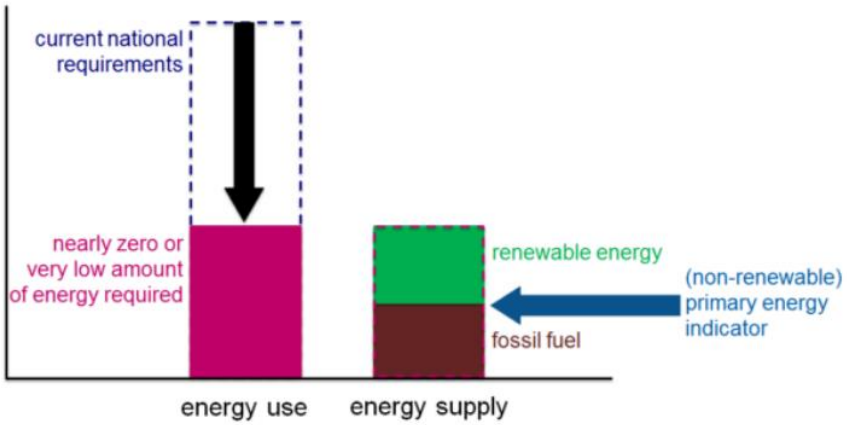


Figure 5.1 - Graphical interpretation of the NZEB definition according to EPBD Articles 2 and 9 (RD-08)

A study of CA EPBD (RD-09) compared the national NZEB definitions. It was found that the definitions differ significantly from each other. Limits for the energy performance are set in addition to primary energy on many different characteristics. Further deviations that prevent from comparing the national NZEB definitions among Member States are:

- different calculation methods
- building culture
- climate
- investment and energy costs

The spreading of hybrid energy systems, like SCORES designed, can be encouraged by an integrated policy between energy efficiency of and the spreading renewables sources. The next paragraph goes more in deep about the Renewable Energy Directive and the application in each Member State and its interaction with NZEB.

5.4 Renewable Energy Systems Directive (RED)

In April 2009, the Renewable Energy Directive (RED) 2009/28/EC (RD-04) was approved. This directive mandates levels of renewable energy use within the European Union and requires that 20% of the energy consumed within the European Union is renewable, the target is pooled among the member states.

RED have facilitated the spreading of renewable sources with the proposal of simplified procedure for renewable source plants. The member states are due to introduce in their building regulations and codes measures to increase the share of all kinds of energy from renewable sources in the building sector (article 13).

An analysis of the applications of directive for the buildings, in coordination with EPBD, has shown that countries choose two different approaches to RES requirements:

- request a direct RES contribution (share in percentage, or minimum amount of kWh/m² per year);
- included an "indirect" RES requirement by setting very low primary energy requirements that can only be met with RES contributions.

Solution \ Country	BE-BR	BE-FL	BE-WA	BG	CY	DE	DK	EE	GR	ES	FI	FR	HR	HU	IT	LT	LV	MT	NL	NO	PL	PT	SE	SK	SL	UK
RES as part of district heating	Y	Y	Y	Y	Y	Y	N	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	N	Y	Y		Y	N	Y	Y	Y
RES as part of district cooling	N	N	N	Y	Y	Y	N	Y	Y	N	Y	Y		N	Y	N	N	N	Y	Y	N	Y	N	N	Y	N
Solar thermal panels for DHW	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Solar thermal panels for heating support	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
PV for self-use	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
PV for feed-in	Y	Y	Y	Y	Y	N	N	Y	Y	N	N	Y	Y	Y	N	Y	Y	Y	Y	Y	N	N	N	Y	Y	N
PV for heating (input to heat storage)	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
PV/T hybrid solar collectors for self-use	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
PV/T: PV for feed-in, T for self-use	Y	Y	Y	N	Y	Y	Y	Y	N	N	N	Y	Y	Y	N	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	N
Micro wind-turbine for self-use	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y
Micro wind-turbine for feed-in	N	N		N	Y	Y	N	Y	Y	N	N		N	N	N	Y	Y	Y	Y	Y	N	N	N	Y	N	N
Local hydro for self-use	N	N	N	N	N	N	Y	Y	N	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y
Local hydro for feed-in	N	N	N	N	N	N	N	Y		N	N	N	N	N	N	Y	Y	N	Y	Y	N	N	N	N	Y	N
Biomass boiler	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y
Biomass CHP	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y/N	Y/N	Y	Y	Y	Y/N	N	Y	Y	Y	Y		Y	N	Y	Y	Y
HP coupled to external or exhaust air	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
HP coupled to ground / ground-water	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Direct geothermal	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Direct ground water cooling	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	N	Y	Y	N	Y	Y	Y	Y	Y	Y	N	Y	Y	Y
RES electricity via grid (specific contract)	N	N	N	Y	N	N	N	N	N	N	N	Y	N	N	N	Y	N	N	N	Y	N	N	N	N	N	N
Alternative: higher insulation level	Y	Y	N	Y	N	Y	N	Y	Y/N	Y/N	N	N	N	N	Y	N	N	N	Y	Y	Y	N	Y/N	N	Y	N

Figure 5.2 - Accountable RES solutions in the MSs' energy performance calculations (RD-08)

Large differences exist across countries regarding those RES solutions, which can be included in their energy performance calculations and those that can be used to fulfil direct NZEB RES requirements. These differences are important to understand and evaluate, because it can encourage or discourage the hybrid systems based on energy storage and reuse.

The evaluation of whether the RES technologies can fulfil direct RES requirements as part of NZEB requirements (currently required in 11 of the 24 countries).

- Solar thermal panels for domestic hot water and PV for self-use are accepted in all 11 MSs
- Solar thermal panels for heating support, biomass boilers, micro wind-turbines for self-use, and PV for heating input are accepted in 10 MSs
- RES electricity via the grid with a specific contract, RES as part of district cooling and local hydro for feed-in are accepted in only a few countries.

Calculations in some MSs do not account for certain RES technologies (e.g. PV/T6, local hydropower) because they are not covered by CEN standards. Additionally, there is no or very little local use of some technologies and therefore no need to develop procedures. In some

MSs there are additional procedures to deal with technologies for which there is no standard calculation defined.

Some MSs impose limits on the amount of locally-generated energy that can be accounted for and some do not allow any exported electricity to be accounted for in order to avoid double-counting in the EPC and grid primary energy factor.

The **main advantages of having limits for the accountable amount of generated electricity** were identified as:

- reducing probability of grid problems (e.g., too much PV in one region causing the grid to become unstable);
- making designers think harder about reducing energy demand;
- avoiding double counting of RES.

The **main advantages of not having limits** were identified as:

- encouraging RES and positive energy buildings;
- making renewable electricity available for more uses (e.g., e-mobility).

The increasing of number of storage energy systems in the buildings will require the **changing of the approach from Member State regarding the limits on the amount of locally generated energy.**

5.5 Energy Performance Buildings Directive update in 2018 with new driver: digitalization, electric mobility and decarbonization existing buildings

On 19 June 2018, Directive 2018/844/EU (RD-05) was published as an amendment of the Energy Performance of Buildings Directive. The revised provisions entered into force on 9 July 2018.

This revision introduces targeted amendments to the current Directive aimed at accelerating the cost-effective renovation of existing buildings, with the vision of a decarbonized building stock by 2050 and the mobilization of investments.

The revision also supports **electro mobility infrastructure** deployment in buildings' car parks and introduces new provisions to **enhance smart technologies** and **technical building systems**, including **automation**.

The Directive 2018/844 introduce the same interesting aspects related with hybrid energy systems, electric batteries and BEMS in the buildings. In the update of article 8 has been introduced:

- the optimizing of technical building systems
- the instalment in not residential new buildings of charging point for vehicles
- the digitalization of the building favoured by the introduction of the “smartness readiness indicator”
- the replacement of inspections with the installation of building automation and electronic monitoring devices

However, legislation and standard shall be improved to allow the introduction of some of the new equipment that will be developed and put on the market to fulfil the European goals.

The EPBD leaves to Member States a large margin of discretion when designing their building codes and implementing technical requirements regarding renovations, building certificates and technical building systems in a way which fits best the national climatic conditions and building stocks.

The Commission Recommendation 2019/1019 (RD-06) on building modernization is drafted as a guideline to support the application of Directive 2018/844.

The aim of this Recommendation is to provide guidance on how to understand and transpose the EPBD, specifically those provisions that concern technical building systems and their inspections, including:

- requirements on installing self- regulating devices and building automation and control systems (Article 8 and Articles 14 and 15 of the EPBD),
- electro mobility recharging infrastructure (Article 8 of the EPBD),
- the calculation of primary energy factors (Annex I to the EPBD).

The EPBD includes requirements for the installation of **self-regulating devices** that can regulate indoor temperature in buildings, with the aim of **improving the management of energy consumption while limiting costs**. It also includes a requirement to install building automation and control systems (BACS) in all (existing and new) non-residential buildings over a certain effective rated output of heating, ventilation, and air- conditioning systems. This is because BACS lead to significant energy savings, improve the management of the indoor environment and, as such, are beneficial to both building owners and users, particularly in large non- residential buildings.

A very important innovation for hybrid technical system spreading, provided by Directive 2018/844, deal with **the obligation to the installation of building automation and control systems in all non-residential buildings** in which the effective rated output of heating, air-conditioning, combined heating and ventilation and combined air-conditioning and ventilation is more than 290 kW. In accordance with Article 14(4) and 15(4) of the EPBD, this must be done **by 31 December 2025** where technically and economically feasible.

Other important improvement is the integration of definition of technical building systems, within the addition of:

- "**technical equipment for building automation and control**", means a system comprising all products, software and engineering services that can support energy-efficient, economical and safe operation of technical building systems through automatic controls and by facilitating the manual management of those technical building systems;
- "**technical equipment for on-site electricity generation**", refers to systems that are designed to produce electricity, that are installed in or within confined boundaries of the premises where the building is located and that have some level of integration with the building and its electrical installation (2). Such systems include, in particular, photovoltaic panels (e.g. roof-mounted photovoltaics panels), micro combined heat and power (CHP) installations and small wind turbines.

Can be useful to integrate the Energy Performance Certificate of the buildings with an evaluation of the consumption also for the car charging (when integrated in the buildings), in this way the storage systems and the renewable energy production during the day can be valorised.

In the Smart Readiness Indicator should be included also an evaluation about whether the BACS also include the energy flow management, with a properly and effective management and choose of the best energy source and the optimization of storage usage (with an intraday and a weekly base).

The analysed directives are focused on the energy performance of buildings and their relationship with renewable source. It is crucial to also analyse the correlation between the building renewable systems and the electric grids.

5.6 Directive on internal market for electricity (Directive 2019/994/EU)

During the last decade, the increasing of renewable plants caused some stability and capacity problem to the electric grids. The introduction of “smartness” in electric grid and the experimentation of new kind of capacity equipment to store or manage the energy produced is become usual for electric companies. A hybrid building system with his own capacity storages can be useful to reduce the load on the electric grid.

The Directive 2019/994 on internal market for electricity (RD-12) is a recast of directive 2009/72/EC, needed also because technological developments have allowed for new forms of consumer participation and cross-border cooperation and there is a need to adapt the Union market rules to a new market reality.

One of the main assumptions is the new rule of the **consumers**: they **have an essential role to play in achieving the flexibility necessary to adapt the electricity system to variable and distributed renewable electricity generation**. Technological progress in grid management and the generation of renewable electricity has unlocked many opportunities for consumers. Healthy competition in retail markets is essential to ensuring the market-driven deployment of innovative new services that address consumers' changing needs and abilities, while increasing system flexibility.

Two important tools recalled by the directive and needed in a modern and effective electric grid, are the **energy storage** and **demand response**, the hybrid building systems can supply both, so it is important that hybrid technical systems are been recognized from the public electric grid and promoted from member state legislation.

The directive foresees an active role for all consumers, that should be able to benefit from directly participating in the market, particularly by **adjusting their consumption according to market signals** and, in return, **benefiting from lower electricity prices or other incentive payments**. Consumers should have the possibility to participate in all forms of demand response. They should therefore have the possibility to benefit from the full deployment of

smart metering systems and, where such deployment has been negatively assessed, of choosing to have a smart metering system and a dynamic electricity price contract.

Each MS should include incentive for storage systems decoupled with BMS, included also in building energy performance calculation methods (EPC, nZEB), that stimulate a grid dynamic use, energy auto-production and allow the spreading of storage electric energy connected to the grid.

5.7 Energy efficiency directive

Moderation of energy demand is one of the five dimensions of the Energy Union Strategy. Measures to improve energy efficiency have a positive impact on air quality as the increased energy efficiency of buildings contributes to reducing the demand for fuel for heating, including solid fuels. Energy efficiency measures therefore contribute to improve the quality of the outdoor and indoor air and contribute to achieving, efficiently in terms of costs, the objectives of the Union's air quality policy. Household energy costs will decrease, and it will contribute to minimize the energy poverty.

Energy efficiency conduces to minimize greenhouse emissions. The transition to economy more efficient about energy profile it should accelerate the spread of innovative technological solutions. Energy efficiency needs to be improved wherever it is economically more advantageous than equivalent solutions on the supply side. This should help exploit the multiple benefits that energy efficiency offers to the MS.

The Directive 2012/27/UE (RD-13) and its amendment directive 2018/2002 (RD-14**Error! R eference source not found.**) are drafted to improving energy efficiency throughout the full energy chain, including energy generation, transmission, distribution and end-use.

Energy Efficiency is a fundamental element for future investment decisions. The key element of the amended directive is a headline Energy Efficiency target for 2030 of at least 32.5%, this means that EU energy consumption should be no more than 1273 Mtoe of primary energy or no more than 956 Mtoe of final energy.

The directive 2018/2002 establishes a common framework of measures to promote Energy Efficiency for MS. It lays down rules to remove market barriers in energy and to overcome the market failures that are holding back efficiency in the supply and use of energy and provides for setting indicative national efficiency targets of energy.

The Directive includes other elements:

- **Stronger rules on metering and billing of energy by giving consumers clearer rights** to receive more frequent and more useful information on their energy consumption. Awareness of consumption improves the use of energy. Directive 2006/32/EU requires MS:

- to ensure that end customers receive at competitive prices individual counters that accurately reflect their actual energy consumption and information actual time of use. When making a connection to a new one building or major renovations are carried out, as defined in Directive 2010/31/EU, individual meters of this type should, however,

always be provided. Directive 2006/32/EU also requires that it be provided clear billing based on actual consumption with frequency that allows consumers to regulate the own energy consumption.

- to have in place transparent, publicly available national rules on the allocation of the cost of heating, cooling and hot water consumption in multi-apartment and multi-purpose buildings with collective systems for such services. By 25th October 2020 it is appropriate that the heat meters and heat meters newly installed they are readable remotely so that consumers have access to information frequently and at affordable costs on consumption.

- Monitoring efficiency levels in new energy generation capacities.

The directive deals with the issue of **energy poverty**. The improvement of efficiency in building energy should be particular benefit to a vulnerable household, including those are found in conditions of energy poverty. The measures of Energy Efficiency must therefore be at the heart of any cost-efficient strategy once to counteract energy poverty. The building stock needs to be converted over to long term in nZEB in accordance with the objectives of the agreement Paris, but current building retrofit rates are low and buildings occupied by low citizens' income in energy poverty are the most difficult to achieve. Reduction of expenditure on energy consumption should be achieved by helping consumers to reduce their energy consumption, by reducing their energy needs through energy efficiency measures for appliances. The MS need to raise awareness of the benefits of increasing Energy Efficiency and providing them with precise information on how to reach it. The increase in Energy Efficiency is also a lot important for the security of the Union's energy supply, as it reduces its dependence from imports of fuels from third countries. The costs and benefits of all Energy Efficiency measures taken, including payback times invested, they should be made fully transparent to consumers.

The monitoring of energy consumption is certainly fundamental in order to identify families in energy poverty and therefore to be able to intervene better, also by identifying the properties to be subjected as a priority to energy retrofit.

5.7.1 Energy Poverty

More and more often we hear about energy poverty, that affects millions of people around the world, producing negative effects on the health and quality of life. The Energy Poverty is a growing phenomenon, although a common definition of energy poverty has not yet been developed, this term indicates the inability of families or individuals to procure a minimum of energy goods and services. In developing countries, some 800 million people do not have access to electricity. Among the causes identified, a combination of low incomes, high energy expenditure and low energy efficiency in homes. Energy poverty also has serious consequences on other aspects of daily life, for example on health (RD-15).

Recently in Europe, with the "Clean Energy for All Europeans" package, the European Commission presented some measures to tackle energy poverty by extending and consolidating energy efficiency and implementing its monitoring between MS through national plans for energy efficiency, energy, and climate. The "Renovation Wave" plan that the European Commission plans to present shortly as part of the European Green Deal, which aims to encourage the process of renovating buildings in a sustainably way throughout the EU, goes in this direction.

The improvement of energy efficiency several positive effects among which helping the alleviation of energy poverty. There are three main components at the basis of energy poverty:

- Low household income;
- High/growing energy prices;
- Inefficient energy performance of buildings concerning thermal insulation, heating systems and equipment.

Nowadays awareness of energy poverty is becoming increasingly widespread in Europe and is considered a political priority by many institutions of the EU. In 2018, the European Commission itself created the Energy Poverty Observatory (EPOV) to tackle this difficulty in European countries, with the purpose to assess, detect and disseminate knowledge and good practices to address the delicate theme. According to the observatory, one in ten people live in this condition, about 10% of European population, this means that there are: people cannot heat their homes during the winter, people cannot make their homes welcoming during the summer and people pay their energy bills and household utilities overdue (RD-16).

An alternative tool that can help reduce household energy expenditure is **energy income**, a territorial initiative to combat energy poverty. In 27 July 2007 there was an agreement between municipality of Porto Torres (Sassari, Italy) and GSE, which involvement an investment by the municipality of 500.000 €. Thanks to this agreement, a photovoltaic system (under 200 KW) will be built for one hundred disadvantages families, so that families can save about 200 €/year on their electricity bill. Families will benefit from the on-site exchange (handled by GSE), while the surplus obtained from the sale of energy to the electricity grid will go to the revolving fund activated by the Municipality of Porto Torres, so that other families can also benefit from it. This is a little example, that show as the collaboration between different entities can lead to great achievements.

In Germany there are many measures (RD-17) to counter this phenomenon, here are some illustrated:

- Caritas electricity saving check: this measure provides certain households with an energy audit to advise on energy efficiency improvements, as well as some basic energy saving equipment (for example LED lights). Long-time unemployed persons are trained to give the advice. Households were also given the option to buy a new energy efficient advices against a lower price;
- Care-energy social tariff Hamburg: this measure limits the electricity bills for low-income households to a maximum of 4% of their income, or alternatively the total energy bills (including electricity, heat, oil, coal, wood, gas) to a maximum of 8% of their income;
- Power limiters instead of disconnection in Cologne: This measure provided households with smart meters that allowed the power supply to be reduced to 1000W in case of non-payment, instead of disconnection.

6 Policy recommendations to stimulate the take-up of hybrid system solutions by the market

On 4th December 2019, the European Environment Agency (EEA) published its report entitled "**The European Environment – state and outlook 2020**" (SOER).

Following the wide debate on the Communication "**A Clean Planet for All**', the EU submitted in March 2020 under the Paris Agreement to the United Nations Framework Convention on Climate Change, committing to become a climate-neutral economy by 2050.

The "**Green Deal**" (2019) (RD-18) is become another driving factor towards a circular economy and decarbonization because of its funds, that have been integrated with Recovery and Resilience Fund in 2020. It was the biggest economic plan in Europe since the Second World War.

The plan illustrates the necessary investments and the available financing instruments, and it provides a time schedule of the action plan. Most of the economic funds will be allocated to investments aimed to sustainability and digitization, two of the sectors involved in the hybrid energy system promoted by SCORES.

Instead, the **European Strategic Energy Technology Plan** (**2014**) (SET) (RD-19), is the guidelines to boost the transition towards a climate neutral energy system through the development of low-carbon technologies in a fast and cost-competitive way. The SET plan aims to accelerate the development of new energy technologies through cooperation on European programs. It brings together more than 175 research organizations from 27 countries, involved in 17 joint programs.

The SET Plan proposes funds for research and development, such as the integration of renewable technologies in energy systems and competitiveness in the global battery sector, which are of interest for hybrid systems.

6.1 Next Generation EU fund

The EU long-term budget 2021-2027 together with **NextGenerationEU** (RD-20), the recovery instrument, form the largest stimulus package ever financed through the EU budget, of €1.8 trillion.

It was agreed following a negotiations process started with a Commission proposal in May 2018. After the coronavirus pandemic hit Europe, a second proposal followed in May 2020, to make sure the budget can better support Europe's recovery.

In July 2020, the EU heads of state approved the next long-term budget and NextGenerationEU, and, moreover, the agreement was sealed also with the European Parliament, on 10 November 2020.

Over 50% of the funds support modernization including research and development, whereas 30% of the amount support the fight against climate change (it is the highest percentage ever for the EU budget).

In this way, these funds can help the implementation of renewable energy systems as well as hybrid systems.

6.2 Economic incentives

The hybrid systems need to be brought into the market with help from the policies of Member States. Indeed, incentives on the use of renewable energies and on the installation of plants can differ significantly for each MS.

Each MS has policies to comply with European standards. An initiative of the European Commission, called “RES Legal- Legal Sources On Renewable Energy” (RD-21), provides a detailed list of current MS schemes regarding the implementation of renewable energy.

The following tables show information on the important legislation on the support schemes, grid issues and policies for energy from renewable sources covering electricity and heating & cooling sector. The first table shows the subsidies to produce electricity from renewable energies.

COUNTRY	ELECTRICITY
ITALY	In Italy, support schemes for RES-E are managed by *Gestore dei Servizi Energetici* (GSE - Manager of Electricity Services). Electricity generated from renewable energy sources is promoted through VAT- and real estate tax deductions. The electricity from renewable energy sources fed into the grid can be sold on the free market or to the GSE on a guaranteed minimum price. Alternatively, renewable energy producers can opt for net-metering ("on-the-spot swap") which provides economical compensation to PV-producers for the electricity fed into the grid. Grid operators are obliged to give priority access to renewable energy plants. They are also obliged to give priority dispatch to electricity from renewable sources. Photovoltaic energy plants are eligible for a reduced VAT of 10%. Furthermore, it is possible to receive a real estate tax reduction for buildings equipped with renewable energy installation from the municipality.
GERMANY	In Germany, electricity from renewable sources is mainly supported through a market premium scheme. For most installations, the award and the level of the market premium is determined through a tendering scheme. Plants with a capacity of up to 100 kW and other plants in exceptional cases can benefit from a feed-in tariff. The criteria for eligibility and the tariff levels are set out in the *Renewable Energy Sources Act* (EEG 2017). Plant operators of RES plants exceeding an installed capacity of 100kW which are not obliged to take part in the tendering procedures are supported by a market premium for electricity they sell directly. The amount of the market premium shall be calculated each month.

COUNTRY	ELECTRICITY
	Moreover, for power plants up 100 kW the support system is based on a feed-in tariff, which the grid operator pays to the plant operators. The amount of tariff is set by law and is usually paid over a period of 20 years. The plant operators can also opt for the market premium.
FRANCE	In France, electricity from renewable sources is promoted through a feed-in tariff, a premium tariff as well as through tenders for the definition of the premium tariff level. In addition, tax benefits are also available. The current support framework still provides that small plants or non-mature energies can benefit from incentive tariffs (Art. 1, Décret du 28 May 2016). Another important change was introduced by the energy transition law in favour of a more flexible electricity market in France: renewable energy producers are no longer obliged to sell their electricity exclusively to national electricity suppliers. The regulation, in particular, extends the management of the obligation to purchase electricity to operators other than EDF or local distribution companies (art. L314-6-1, *Code de l'Énergie*). Electricity generated from renewable energy sources is promoted through various tax incentives. People who invest in renewable energy plants can benefit from an income tax credit (Crédit *d'Impôt*). In addition, people who install photovoltaic systems on buildings can benefit from a reduced VAT rate.
SWEDEN	The Kingdom of Sweden promotes renewable energy through various incentives, the most important of them being the quota system, which is based on a certificate trading system. The Electricity Certificates Act obliges energy suppliers to prove that a certain quota of the electricity supplied by them was generated from renewable energy sources. Furthermore, tax regulation mechanisms and a subsidy scheme have been introduced, as for photovoltaic installations.
DENMARK	In Denmark, electricity from renewable sources is promoted through a premium tariff and net-metering. In addition, local initiatives for the construction of solar energy plants are supported through loan guarantees. The operators of renewable energy plants usually receive a variable bonus, which is paid on top of the market price. Regarding net-metering, electricity producers using all or part of the electricity produced for their own needs are totally or partly exempt from paying Public Service Obligation on this electricity. The Public Service Obligation is a charge levied to support renewable energy.
NETHERLANDS	

COUNTRY	ELECTRICITY
	The Netherlands has introduced a premium tariff to promote the generation of electricity from renewable energy sources. Generators of electricity from renewable energy sources that use the electricity they consume may be exempt from the tax levied on electricity consumption. Moreover, investors in RES-E projects are eligible for a reduction of the interest rate on the basis of a Green project declaration.
AUSTRIA	In Austria, electricity from renewable sources is supported mainly through a feed-in tariff, which is set out in the Okostrogesetz 2012. Moreover, subsidies granted for the PV installations on rooftops and building-integrated installations with a capacity of 5-200 kW.
PORTUGAL	In Portugal, electricity from renewable energy plants is promoted through a feed-in tariff. The feed-in tariff consisted of two elements: a guaranteed payment rate and an amount calculated by a statutorily set formula. For new small production installations, a remuneration regime came into force in 2015. This remuneration regime is based on a bidding model in which producers offer discounts to a reference tariff.

The second table shows the subsidies to produce heating and cooling from renewable energies.

COUNTRY	HEATING AND COOLING
ITALY	A price-based scheme (*Conto Termico*) is in place in Italy for small RES-H sources. Heat pumps (aero thermal, geothermal, hydrothermal), biomass and solar thermal are eligible technologies and the incentive is granted for a period varying between 2 and 5 years. Furthermore, a tax regulation system is currently in place for the promotion of RES-H. Conto Termico and Tax detractions are not combinable.
GERMANY	In Germany, the Guidelines for the support of RES-H set out the *Market Incentive Programme* (MAP), stipulating support schemes for the promotion of heat produced from renewable energy. BAFA is providing investment support and KfW offers low-interest loans (*Renewable Energy Programme–Premium*). The "*KfW Renewable Energy Programme- Standard*" provides low-interest loans with grant payback support for the development and expansion of heat installations/plants
FRANCE	

COUNTRY	HEATING AND COOLING
	In France the generation of heat through renewable energy plants is promoted through two systems of energy subsidies, two tax regulation mechanisms as well as through the granting of a zero percent-interest loan. The zero percent-interest loan for housing renovation has been introduced within the frame of the *Environment Grenelle*. The French government has introduced a national programme to support households with low income in the thermal renovation of their buildings in order to decrease energy losses called "*habiter mieux*". Moreover, there is a heat fund (Fonds Chaleur), which supports the production of renewable heat through the publication of yearly tenders. The production of heat from renewable energy sources is promoted through several tax incentives. Persons investing in renewable energy plants are eligible for an income tax credit (*Crédit d'Impôt*). Furthermore, persons that install certain heat production installations in buildings are eligible for a reduced VAT rate.
SWEDEN	In Sweden, tax exemptions are the main incentives to support renewable heating. Indeed, energy and carbon dioxide taxes are levied on the supply, import and production of fossil fuels for heating purposes, while renewable energy sources are exempt from these taxes. Equally, the producers of heat are obliged to pay a tax according to their nitrous oxide emissions, while heat producers using renewable energy sources are exempt from this obligation.
DENMARK	In Denmark there are several taxes on the production, supply and use of energy sources for heating purposes. Renewable energy sources are exempt from these tax obligations.
NETHERLANDS	The Netherlands have introduced a premium tariff to promote the generation of heat from renewable sources. Enterprises are eligible for a tax credit for investments in specific types of renewable heating systems. Moreover, investors in RES-H&C projects are eligible for a reduction of the interest rate on the basis of a Green project declaration.
AUSTRIA	The most substantial form of supporting small-scale RES heating and cooling is provided by the Environmental Assistance in Austria (UFI) programme. There are special investment incentives for solar thermal installations, heat pump, geothermic and biomass heating plants.
PORTUGAL	In Portugal, the Energy Efficiency Fund (FEE) provided a subsidy to investments in solar thermal installations for heating water through

COUNTRY	HEATING AND COOLING
	"Efficient Buildings 2016" that opened for new applications on 8 July 2016 and ran until 8 November 2016.

Finally, the last table shows policy for the implementation of renewable energies.

COUNTRY	POLICY
ITALY	In Italy, training programmes are developed at regional level. Certificates of installed plants is obligatory. All new or refurbished buildings must integrate RES, with an additional 10% to the obligation level for public buildings. A guarantee fund is in place for supporting district heating network development. The liberalization of the energy market is foreseen for 2022.
GERMANY	Germany provides policies for the promotion of renewable energy sources covering training, certification and research programmes, a self-commitment of public authorities, the support of district heating networks and the introduction of building obligations regarding the use of heat produced from renewable energy.
FRANCE	In general there are two types of training programmes for installers of RES-systems: The association *Qualit´EnR* promotes quality installations in the field of solar thermal energy, geothermal energy, photovoltaic, biomass as well as heat pumps. The organization *Qualibat* grants qualifications and certifications to professionals of the building trade, including installers of renewable energy plants. There is one Research, Development and Demonstration Programme: The "Investment for the Future" program (Investissement d'avenir) supports demonstration projects in the field of environmental innovation. There are two support schemes for RES-H infrastructures: The Heat Fund (*Fonds Chaleur*) supports the production of heat through renewable energy plants as well as the use of district heating. Moreover, under certain conditions, the supply of heat through district heating networks can be subject to a reduced VAT of 5.5%.
SWEDEN	The grants are provided to enterprises in order to promote efficient and environmentally friendly energy supply, energy efficiency and to encourage the purchase of efficient energy technologies. Grants are awarded only until the funds are exhausted (1 Regulation No. 2003:564). Following measures are eligible: Environmental sustainability projects, Environmental studies, Technology grants.

COUNTRY	POLICY
DENMARK	There are 2 training programmes for RES-installers, a certification scheme for wind energy plants, a research, development and demonstration (RD&D) programme and an obligation to use renewable heating in new and renovated buildings.
NETHERLANDS	The Netherlands Enterprise Agency (Rijksdienst voor Ondernemend Nederland) facilitates market parties and specific organizations to set up training and educational facilities for installers. Innovation in renewable energy techniques is supported through innovation contracts between private companies, universities and R&D institutes.
AUSTRIA	There are four different specialization programmes for RES-installer (certified heat pump installer, certified solar heat installer and planner, certified photovoltaic installer and planner, certified biomass heating installer). While RE measures in industrial and commercial buildings are mainly supported at the federal level through the Environmental Aid act, RE measures for residential buildings largely fall within the sphere of competence of the federal states.
PORTUGAL	In Portugal, the government created a fund to finance research and projects on innovation and technological development in the field of renewable energy, as well as to support campaigns raising awareness on RES issues. With regard to policies in the building sector, the obligation to use solar thermal collectors for heating and water and other regulations on the certification of performance and durability of installations and components are in place. In addition, training programmes for installer of RES plants are already part of the education system.

6.2.1 Italy

Electricity generated from photovoltaic energy plants is promoted through VAT- and real estate tax deductions. Furthermore, a tax regulation system is currently in place for the promotion of heating and cooling by renewable energy sources. These tax regimes can aid the implementation of hybrid systems in Italy.

6.2.2 Germany

Germany provides policies for the promotion of renewable energy sources through a market premium scheme for the production of electricity and support schemes for the promotion of heat. Germany is one of the MS with more subsidies for renewable energy, where the implementation of hybrid systems is facilitated.

6.2.3 France

France, as Germany, has a different and complex system of tax regimes. There are multiple grants and funds that can be used for the implementation of hybrid systems. People who invest in renewable energy plants can benefit from an income tax credit and, in addition, people who install photovoltaic systems on buildings can benefit from a reduced VAT rate. Moreover, the production of heat from renewable energy sources is promoted through several tax incentives.

6.2.4 Sweden

In Sweden, tax exemptions and grants encourage the purchase of efficient energy technologies. Sweden looks with interest at new technologies and promotes energy efficiency. Therefore, with the help of these exemptions, a hybrid system can be integrated easily on the market. Indeed, Sweden is one of the most developed countries about renewable energy.

6.2.5 Denmark

Denmark, as Sweden, promotes the use of renewable energy through tax exemptions and a premium tariff. Therefore, energy efficiency is promoted through a series of grants and exemptions, which can be used for the implementation of hybrid systems. Moreover, there are a *research, development and demonstration* (RD&D) *programme* and an obligation to use renewable heating in new and renovated buildings.

6.2.6 Netherlands

Also, Netherlands, promotes the use of renewable energy through tax exemptions and a premium tariff. Innovation in renewable energy techniques is supported through innovation contracts between private companies, universities and R&D institutes. Surely, the introduction of hybrid systems into the market can be helped by these policies.

6.2.7 Austria

In Austria, there are special investments incentives about renewable energy systems, but heating and cooling is supported through an incentive scheme on the level of the individual federal states ("Länder"). Surely, this may not be helpful for promoting hybrid systems. However, electricity from renewable sources is supported mainly through a feed-in tariff and there are subsidies granted for the PV installations.

6.2.8 Portugal

In Portugal, the government created a fund to finance research and projects on innovation and technological development in the field of renewable energy. Electricity from renewable energy plants is promoted through a feed-in tariff, however no direct support scheme for RES in the heating sector is available. It is definitely not one of the best markets for hybrid systems.

6.3 Energy Community

The exploitation of the energy produced by solar panels can be optimized through the **Energy Community**.

An Energy Community is a group of people who share renewable and clean energy. Therefore, Energy Communities represent an innovative model for the production, distribution, and consumption of energy from renewable sources. This model bases its values on the fight against energy waste and on the sharing of a fundamental asset at a competitive price.

To better explain these Smart Communities, we must first introduce the concept of **Smart Grid**, thanks to which everyone can become part of an energy community: whoever owns a photovoltaic system connected to the grid (and is therefore a *prosumer*) can share his excess energy with other consumers. Anyone can be part of one of these communities that share clean energy, thus cutting down on energy waste and bills.

The term *prosumer* is used to refer to the user who is not limited to the passive role of *consumer*, but actively participates in the production process (*producer*). Therefore, the prosumer is the one who owns an energy production plant, of which he consumes a part of it. The remaining part of energy can be fed into the grid, exchanged with consumers physically close to the prosumer, or even accumulated in a special system and therefore returned to the consumption units at the most appropriate time. Hence**, the owner of a hybrid system** could be a potential *prosumer,* which is an active player in the management of energy flows, and can enjoy not only relative autonomy but also economic benefits.

Energy Communities are a reality that is present and necessary also to stimulate the production and consumption of renewable energy. Indeed, these realities are already widespread and consolidated in other European countries, such as the United Kingdom, Spain, France, Italy and Germany as well. Their growth is facilitated by effective systems of financing and incentives, a clear regulatory framework and public awareness.

7 Standardization about hybrid energy system in buildings

This chapter deals with the standards for the whole HVAC system in a building, exploring the methodology and looking for the gap for the spreading of building hybrid energy systems.

7.1 European standard about energy performance of buildings

For the comprehensive application of EPBD, the European Commission provides three standardization mandates to CEN, CENELEC and ETSI[1]:

- M343 (issued in 2004) for a methodology calculating the integrated energy performance of buildings and estimating the environmental impact
- M350 (issued in 2004) for the development of horizontal standardized methods for the assessment of the integrated environmental performance of building
- M480 (issued in 2010) for the elaboration and adoption of standards methodology calculating the integrated energy performance of buildings and promoting the energy efficiency of buildings, in accordance with the terms set in the recast of the Directive on the energy performance of buildings (2010/31/EU)

The improved set of EPBD standards shall become a systematic, clear and comprehensive package for the benefit of professionals, Member States and relations with third countries.

In order to ensure user-friendliness, a continuous but modular overall structure is been developed, covering all standards related to the energy performance of buildings, providing the overall framework which enabled a step-by-step implementation by the EU Member States.

The mandated works include guidance on the rationalization of different options given in the standards, providing a balance between the accuracy and level of detail, on one hand, and the simplicity and availability of input data, on the other. Hidden complexities will also be considered, such as the impact of differences in the overall legal frameworks on the national choices and national input data.

The horizontal coordination of the work under M480 has been allocated to:

- CEN/TC 371 - Energy Performance of Building project group

Five CEN technical committees have been assigned the task of developing the required standards:

- CEN/TC 089 - Thermal performance of buildings and building components
- CEN/TC 156 - Ventilation for buildings
- CEN/TC 169 - Light and lighting
- CEN/TC 228 - Heating systems in buildings
- CEN/TC 247 - Building automation, controls and building management

[1] http://ec.europa.eu/growth/tools-databases/mandates/

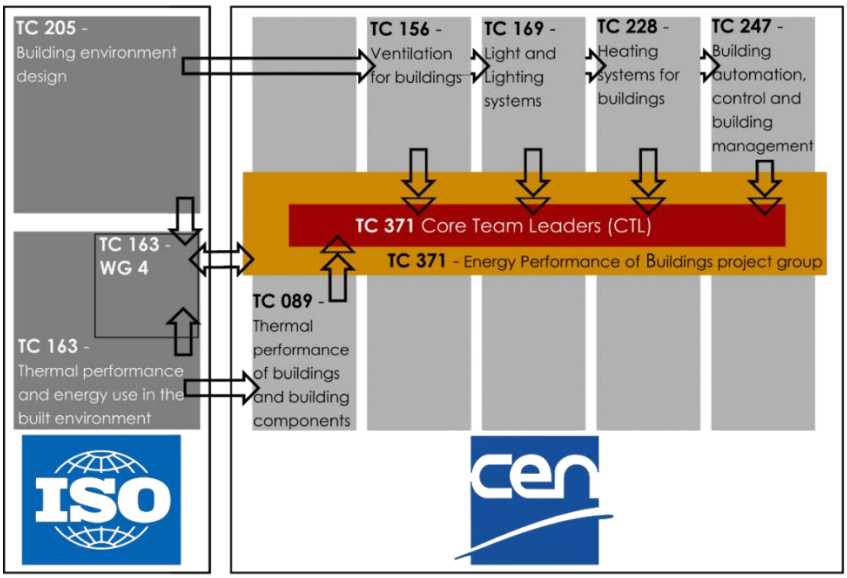


Figure 3 – CEN and ISO TC involved in EPB

A new generation of EBP standards have been prepared or revised by the five CEN (European) and two ISO (worldwide) Technical Committees, or TC's, each of them covering a specific field of expertise. These committees were coordinated by a group of Core Team Leaders (CTL) of the CEN TC 371, the Programme Technical Committee of the EBPD, in order to ensure effective management and consistency of the overall approach. The CTL, in turn, collaborated with the joint working group of ISO TCs 163 and 205 (with global coverage).

These joint efforts aimed at a complete and consistent set of EN ISO EPB standards. Thus, several EPB standards were prepared or revised as combined EN ISO standards or, when this was not achievable, the ISO and EN versions were kept as similar as possible, with the aim of merging them at a later stage. A series of consecutive ISO numbers has been reserved for the EPB standards to support this plan and to increase global awareness of the EPB set: the numbers range from EN ISO 52000 to 52150, with sub-series for the successive modules.

7.2 Open issues and proposals for valorization of hybrid systems in standard

The main impact of EPBD directive is the improvement of energy efficiency of the building, it is done mostly with the definition of energy performance index used for:

- the building refurbishment and new construction (nearly zero-energy building)
- the buy and rent of buildings (energy performance certificate)
- the demand of public incentives

The energy performance indexes are obtained with the calculation method defined in CEN standard drafted in mandates 343, 350 and 480 (see § 7.1).

The main advantage to use a hybrid system is the almost entirely use of renewable sources on site.

To encourage the spreading of hybrid systems, the energy performance indicators chosen for the evaluation of energy performance of the buildings and for the energy certificates shall be computed with a **valorization for on-site auto-consumption renewable energy**.

A common general framework for the calculation of energy performance of buildings has been provided in Annex I of EPBD 31/2010 (updated from directive 884/2018).

The energy performance of a building shall be determined on the basis of **calculated or actual energy use** and shall reflect typical energy use for:

- space heating
- space cooling
- domestic hot water
- ventilation
- built-in lighting
- other technical building systems

The directive also defines a common energy performance indicator for EPC and minimum energy performance requirements:

"*The energy performance of a building shall be expressed by a numeric indicator of primary energy use in kWh/(m^2 y) for the purpose of both energy performance certification and compliance with minimum energy performance requirements.*"

And

"*For the purpose of expressing the energy performance of a building, Member States may define additional numeric indicators of total, non-renewable and renewable primary energy use, and of greenhouse gas emission produced in kgCO_2 eq/(m^2 .y)*"

The crucial sentence of directive that allow to propose further innovation in calculation method is:

"*The methodology applied for the determination of the energy performance of a building shall be transparent and open to innovation.*"

For hybrid energy systems several elements are crucial for the valorization of the energy efficiency computations:

- space heating energy use
- domestic hot water energy use
- complete use of electric energy produced by renewable sources
- renewable source integration on primary energy use

Another important sentence of EPDB in Annex I are:

"In the calculation of the primary energy factors for the purpose of calculating the energy performance of buildings, Member States may take into account ***renewable energy sources supplied through the energy carrier and renewable energy sources that are generated and used on-site, provided that it applies on a non- discriminatory basis.***';

The non-discriminatory base between on-site and distant renewable source allows a further use of renewable source outside the building site, but not incentive the spreading and the increasing of on-site renewable source use.

In order to encourage local production of energy a preference to the on-site renewable energy shall be guaranteed, **the European States can promote the use of on-site renewable energy using the Renewable Energy Ratio as defined in ISO 52000-1:2017** (RD-22).

In clause 9.5.1 of ISO 52000-1 the delivered energies are classified in:

- **on-site**: premises and the parcel of land on which the building(s) is located and the building itself.
- **nearby** the building site on local or district level (e.g. district heating or cooling)
- **distant** to the building site not on-site nor nearby

The renewable energy ratio is given by formula:

$$RER = \frac{E_{\mathrm{Pren;RER}}}{E_{Ptot}}$$

Where:
E_{Ptot} is the total primary energy
$E_{Pren;RER}$ is the renewable primary energy taking into account the perimeters. The perimeter is defined at national level using Table A.24 ISO 52000-1, if there is no specific decision at national levels, the on site and nearby renewable energy is included, and distant renewable energy is excluded (Table B.24 ISO 52000-1).

In order to incentive the spreading and increase of local renewable sources the European States can include into the local legislation the RER parameter, and require that the RER value for new and refurbished building will be maintained as high as possible.

In Table B.24 the numerator of RER, $E_{Pren;RER}$ is the sum of on-site and nearby renewable sources (excluding distant renewable source).

Perimeter choice	Choice – RER calculation (renewable energy)	Choice – RER calculation (total energy)	Choice – EPB calculation (delivered energy)
On-site	Yes	Yes	Yes
Nearby	Yes	Yes	Yes
Distant	No	Yes	Yes

Figure 4 – Table B.24 ISO 52000-1

In ISO 52000-1:2017 all the overall energy performance indicators (clause 9.6.1 ISO 52000-1) are calculated as the difference between delivered energy and exported energy:

$$E_{we} = E_{we;del;an} - E_{we;exp;an}$$

Where:
$E_{we;del;an}$ Annual weighted delivered energy, taking into account only the energy carriers delivered from the perimeters
$E_{we;exp;an}$ Annual weighted delivered energy, exported from the perimeters (renewable source produced but not used on site)

Other important factor to considering is the k_{exp}, it defines which part of the exported energy is included in the energy performance of the building. Its value can go from 0 to 1. Currently, the value is fixed to 1 in informative Annex B.

Considering the value of k_{exp}, as a function of the capability of the renewable system to store and use effectiveness the delivered energy on site, for example with BEMS integrated that manage properly the energy flow, can be a way to encourage the development of buildings that effect as less as possible on the external grid and reach to consume all the energy produced on site.

In Annex H (informative) has been proposed indicators for the assessment of nearly Zero Energy Buildings. Despite the informative nature, the final indicator defined is useful and already adopted in national legislation (e.g. Italy). The final indicator proposed in **non-renewable primary energy use with compensation**, using this value could be useful to encourage the production from renewable energy, independently by the on-site production.

Using the "non-renewable primary energy use with compensation" as indicator for energy certificates and minimum energy requirement for new and refurbished building has several implications:

- the benefit that the indicator excludes all the renewable energy production, that incentive the use of renewable source
- there is no distinction between on-site and distant renewable sources, and moreover the renewable energy produced on site is enhanced even if exported on the energy grid

It is useful to integrate the "non-renewable primary energy use with compensation" indicator with RER in order to take in account properly the on-site renewable energy production.

Alternatively, it is possible to choose as an indicator "non-renewable primary energy use without compensation", in order to discourage the production of renewable energy not used on site.

8 Second life Li-Ion batteries: legislation, standard and policy analysis

Industrial Li-ion batteries have been introduced into the industrial market for residential and commercial installations quite recently, drawing on the extensive experience gained in the development of batteries for electric and hybrid vehicles.

About 200 MW of stationary Li-ion batteries are currently operating worldwide in grid-connected installations, a figure which is rapidly increasing.

The choice of Li-ion is justified by its long lifespan, high energy efficiency, operation at undefined / low state of charge, as well as its compactness, maintenance-free design, and system communication capability.

A major advantage of Li-ion technology is its versatility: it is highly scalable, and it can be adapted to practically any voltage, power, and energy requirement. Li-ion batteries require sophisticated control electronics, which, on the one hand, makes the technology somewhat complex, but which, on the other, offers precise management and state of charge control in 'smart' applications.

Research on Li-ion batteries will further increase energy density, cycle, and calendar life. Economies of scale and industrial capacity for the mass production of industrialize cells and batteries will contribute to cost reduction. Different system solutions will be developed following an increase in market volume.

Li-ion batteries meet the average recycling rate of 50% mandated for this family, and recycled materials are reused by other industries where they replace the extraction of primary metals. As this technology is growing fast, recycled material from volumes currently collected – sold at a time when the Li-ion market share was insignificant – do not match the quantities required to manufacture batteries offered on the market today; therefore, due to its growth, this segment is currently a net 'taker' of raw materials.

In the following paragraph it is reported the mainly European Legislations and Standards for Li-Ion batteries and the mainly issues related to their growing in EU market.

8.1 Legislation about Li-Ion batteries

Requirements for Lithium –Ion batteries placed on the European Union market in accordance with the **Batteries Directive 2006/66/EC**, **Regulation 1103/2010** and **Directive 2023/56/EU**, and corresponding national laws. The batteries must be marked with the crossed wheel bin symbol and may be submitted to specific conditions for collection and recycling.

Lithium-ion batteries, which **contain electronic modules,** and which are subject to the EMC directive 2014/30/EU, must be approved and must wear the CE marking. The CE marking is also applicable to **various equipment containing batteries, such as equipment submitted to the Eco-design Directive** 2009/125/EC or **noise emissions Directive** 2000/15/EC, systems for potentially **explosive atmospheres** (ATEX) Directive 2014/34/EU, **low voltage** equipment (75-1500 V DC) according Directive 2014/35/EU, ROHS, medical equipment, machineries, etc…

Batteries that can be used by consumers should comply with the General Product Safety Directive (GPS) 2001/95/EC.

8.1.1 Waste Treatment legislation

Directive 2006/66/EC on batteries and accumulators, and waste batteries and accumulators, and Commission Regulation EU 493/2012 applies. Dispose of waste batteries in accordance with national legislation.

When collected waste batteries must undergo recycling to comply with national regulations. Batteries should not be disposed of into the environment. Clean packing material may be recycled according to local and national regulations.

According to the European Waste Catalogue (EWC), Waste Codes are not product specific, but application specific. Waste codes should be assigned by the user, preferably in discussion with the waste disposal authorities.

Suggested EWC-codes according to waste disposal are:

- N°: 16 06 05, other batteries & accumulators
- N°: 20 01 34, unsorted batteries and accumulators containing these batteries

8.1.2 Transportation legislation

Li-ion batteries are classified as Dangerous Goods for transport according to the UN Model regulation for the Transport of Dangerous Goods (**UN 38.3 Recommendations on the transport of dangerous goods. Manual of tests and requirements**) a kind of certification necessary for the transportation.

8.1.3 Certification LI-ion Batteries

For R100, Li-ion batteries are classified under CLASS 9 Dangerous Goods due to their dual hazard properties associated with their chemical and electrical content

UN 3480 : Lithium-Ion Batteries
UN 3481 : Lithium-Ion Batteries contained in equipment or packed with equipment.

Prior to any shipment, the compliance with the following requirements points must be fulfilled:

- The Transport of Li-ion batteries (Dangerous Goods) is organized by appropriately trained persons and/or the shipment is accompanied by corresponding experts or qualified companies.
- The Lithium-Ion battery is of the type proved to meet the tests requirements of the UN Manual of Tests and Criteria, PartⅢ, sub-section 38.3 ;
- In accordance with the requirements of the UN Model Regulation, Chapter 2.9.4, the manufacturer of the battery or the battery pack shall make available on request of the Competent Authority the evidences that a Quality Certification program is in place in its manufacturing facility for Lithium-ion batteries.

The European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR) has been updated. The new version is applicable as from 1 January 2017. It includes several changes concerning the transport and packaging of batteries, particularly lithium batteries classified UN 3480 and UN 3090, as well as the batteries transport in or with equipment, classified UN 3481 and UN 3091.

8.1.4 Installation of 2nd Life Li-Ion batteries - Safety issues

Li-Ion batteries have been very successful in recent years. Their overall failure rate is very low compared to the total number of batteries in use worldwide. However, in recent years there have been episodes where the batteries were at the origin of fires and dangerous accidents.

This technology offers on the one hand a high energy density and at the same time the lithium ions can react chemically very quickly, so that conditions of "thermal instability" can be generated when the operating conditions are outside the established ranges.

Some of the conditions that can cause malfunctions are:

- Overload - may cause the positive electrode to react with the electrolyte, with consequent generation of heat, pressure increase and consequent fire.
- Over discharge - may cause damage to the cathode of the electrolytic cell, formation of plaques and dendrites and consequent internal short circuit due to perforation of the diaphragm.
- Overheating - may cause the negative electrode to react with the electrolyte.
- Short circuit ("external", at the terminals) - can cause overheating and pressure build-up.
- Mechanical stress - can cause damage and deformation of the cells, such as to cause possible internal short circuits and other faults.

A battery can have a malfunction caused by an incorrect connection between the electrodes. Other types of malfunctions can be caused by extreme temperatures, overcharging, over-discharge, mechanical stresses, and imbalances in the state of charge of the cells inside the battery pack.

At the system level where two or more batteries are connected, a malfunction can occur due to incorrect connection between the batteries, faulty connection of the battery pack with the load or with the charger, from the malfunction of a single module.

To mitigate and avoid the effects due to improper use of the batteries, attention must be paid to the choice of technology, system configuration and parameters that determine system security.

To achieve a safe and robust design, it is crucial to identify the characteristics and requirements of energy storage for a specific application. The optimization of the performance and safety of Li-Ion batteries is achieved by paying particular attention to the specifications, electrical and mechanical design and to the regulatory standards to be applied.

Most countries follow rules and regulations that require products to be evaluated against a set of safety criteria based on their intended use.

The most common and widely accepted standards are based on the proposed legislation and published by the International Electrotechnical Commission (IEC), Underwriters Laboratories (UL), and United Nations (UN). The following list describes some essential points of the international legislation concerning lithium-ion cells and modules, with reference to portable and stationary applications and "Light Electric Rail" (LER).

Part of the legislation for non-stationary applications, although important for product design and safety, is not mentioned in this document.

- **UL 1642 Lithium Batteries** - this is a safety standard that defines requirements intended to reduce the risk of fire or explosion when lithium batteries (or cells) are used in a product.
- **IEC 62133 Secondary cells and batteries containing other types of alkaline or non-acid electrolytes** - Safety requirements for sealed secondary cells and batteries composed of them, for use in portable applications.
- **UL 1973 batteries for use in 'Light Electric Rail' (LER) and stationary applications** - The standard assesses the capacity of the electrical energy storage system to withstand stress simulated conditions in safety. From UL 1973, a key passage is reported: *5.7.3 Electronic circuits and control software, as primary safety protection, must be examined against the Standard that defines the tests for safety control systems using solid state devices, UL 991; to the legislation concerning programmable component software (UL 1998); or to the standard for the functional safety of programmable electric / electronic / electronic devices, IEC 61508 series, applicable based on the complexity of the control systems.*
- **UL 991 - Standards for safety tests concerning the use of solid state devices**

R100 define the safety for stationary installation.

Regardless of the chemistry of the cell used, most of the batteries and energy storage systems use a battery management system (**BMS-Battery Management System**), which is composed of electrical circuits for cell management, balanced distribution load and other operational monitoring and control functions. In the industrial sector, the most used name for batteries with integrated BMS is "Smart Battery". However, not all batteries with integrated BMS or "Smart Battery" are designed with adequate safety and protection measures to avoid malfunctions at the cell, battery, or system level. The causes that cause the failure of cells and batteries can be very varied and safety is compromised when the components are damaged. To avoid accidents, reference is made to standards such as **UL 1973, which define tests to ensure safety during use**. For example, tests are defined on the entire product in conditions of overcharging, short circuit, over-discharge, and extreme temperatures. **Since BMSs use solid state devices** (or semiconductors) to implement safety functions, **these must be designed using UL 1973 and UL 991** standards and must be tested to verify safe operation after a failure is made at one point in any of the system. A robust BMS design should include redundant security systems to ensure safe operation even in critical conditions.

8.2 Standard about Li-ion batteries

In 2012, EU and US regulators signed a cooperation agreement regarding Electric Vehicles, the Transatlantic Cooperation on Standards for Electric Vehicles, to avoid the proliferation of conflicts over standardizing the safety of electric vehicles and batteries. The cooperation constitutes the basis for the harmonization and alignment of standards in the electro mobility sector, with obvious repercussions on the stationary storage sector.

The storage systems based on Lithium-ion technology are made up of secondary or rechargeable cells (ESS: Energy Storage System) and are managed by sophisticated electronic components (BMS and electronic components) that ensure the required performance and a certain level of safety: the reliability of all the components of a storage system is the central aspect for both safety and performance.
Lithium-ion electrochemical storage systems are used in three macro-areas:

- consumer electronics,
- stationary storage,
- electric mobility.

The standard collected in the follow table deal with only the lithium-ion batteries for stationary applications, as close as possible to the use in SCORES project. The standard is been classified in the follow areas:

- CLASSIFICATION: only nomenclature and classification of components
- PRODUCTION: standard drafted for the production phase (design, performance and safety test in production phase)
- TRANSPORT: transport of batteries from production plant to construction site
- INSTALLATION: connection of batteries with hybrid energy system
- OPERATION, MAINTENANCE: during the operational life of the system

The main standard in the operation phase are IEC 62619 and IEC 63056:2020.
They cover safety requirements for secondary lithium cells and batteries for use in Electrical Energy Storage Systems.
IEC 62619 had been developed in 2017 as an umbrella standard and covered various industrial applications.

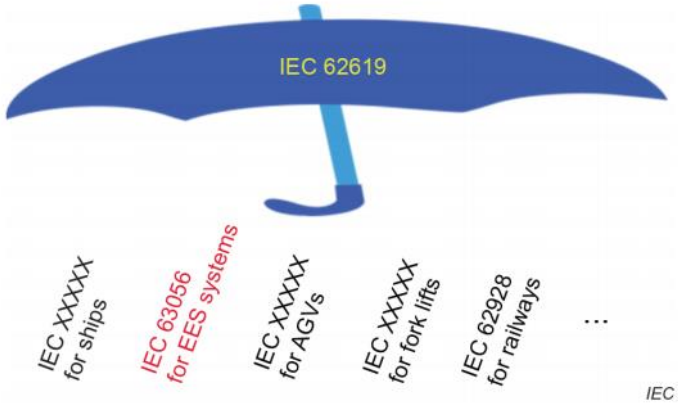


Figure 5 – IEC 62619 as umbrella standard

IEC 63056 has been developed for lithium-ion Batteries and Battery Management applied in stationary applications, including uninterruptible power supply (UPS), rural electrification, and solar photovoltaic (PV) systems. These standards should be referenced when procuring and evaluating equipment and professional services.

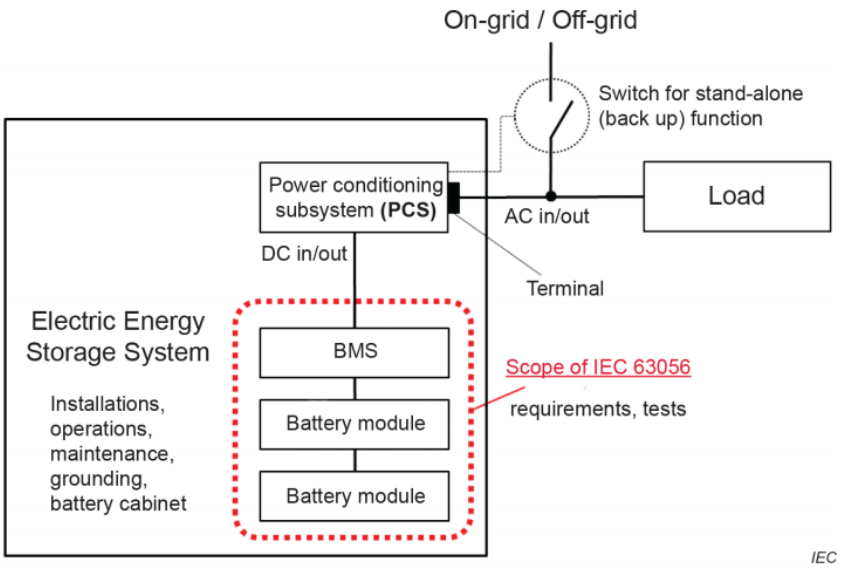


Figure 6 – Figure 2 IEC 63056:2020 Scope of standard

8.3 Referenced Standards

Topic	Technical Committee	Publication Date	Standard	Title	Content
CLASSIFICATION Li-ion Batteries for Stationary Uses	PE/ESSB - Energy Storage & Stationary Battery Committee	06/12/2017	IEEE 1679.1-2017	IEEE Guide for the Characterization and Evaluation of Lithium-Based Batteries in Stationary Applications	Guidance for an objective evaluation of lithium-based energy storage technologies by a potential user for any stationary application is provided in this document. IEEE Std 1679-2010, IEEE Recommended Practice for the Characterization and Evaluation of Emerging Energy Storage Technologies in Stationary Applications is to be used in conjunction with this document. Secondary (rechargeable) electro-chemistries with lithium ions as the active species exchanged between the electrodes during charging and discharging are included in the category of lithium-based batteries for the purposes of this document. Lithium-ion, lithium-ion polymer, lithium-metal polymer, and lithium-sulfur batteries are examples of secondary lithium-based batteries. Primary (non-rechargeable) lithium batteries are beyond the scope of this document. A technology description, information on ageing and failure modes, a discussion on safety issues, evaluation techniques, and regulatory issues are provided in this document. Sizing, installation, maintenance, and testing techniques are not covered, except insofar as they may influence the evaluation of a lithium-based battery for its intended application.

Topic	Technical Committee	Publication Date	Standard	Title	Content
PRODUCTION Requirements and Tests **Industrial and Stationary Applications**	TC 21 - Secondary cells and batteries	25/11/2014	IEC 62620	Secondary cells and batteries containing alkaline or other non-acid electrolytes - Secondary lithium cells and batteries for use in industrial applications	IEC 62620:2014 specifies marking, tests and requirements for lithium secondary cells and batteries used in industrial applications including stationary applications. When there exists an IEC standard specifying test conditions and requirements for cells used in special applications and which is in conflict with this standard, the former takes precedence. The following are some examples of applications that utilize the cells and batteries under the scope of this standard. - Stationary applications: telecom, uninterruptible power supplies (UPS), electrical energy storage system, utility switching, emergency power and similar applications. - Motive applications: fork-lift truck, golf cart, AGV, railway, and marine, excluding road vehicles. This standard applies to cells and batteries. If the battery is divided into smaller units, the smaller unit can be tested as the representative of the battery. The manufacturer clearly declares the tested unit. The manufacturer may add functions, which are present in the final battery, to the tested unit.
PRODUCTION Requirements and Test **PV Applications Off Grid**	TC 21 - Secondary cells and batteries	23/04/2013	IEC 61427-1	Secondary cells and batteries for renewable energy storage - General requirements and methods of test - Part 1: Photovoltaic off-grid application	IEC 61427-1:2013 is part of a series which gives general information relating to the requirements for the secondary batteries used in photovoltaic energy systems (PVES) and to the typical methods of test used for the verification of battery performances. This part deals with cells and batteries used in photovoltaic off-grid applications. This standard is applicable to all types of secondary batteries.

Topic	Technical Committee	Publication Date	Standard	Title	Content
PRODUCTION Requirements and Test **PV Applications On Grid**	TC 21 - Secondary cells and batteries	28/08/2015	IEC 61427-2	Secondary cells and batteries for renewable energy storage - General requirements and methods of test - Part 2: On-grid applications	IEC 61427-2:2015 relates to secondary batteries used in on-grid Electrical Energy Storage (EES) applications and provides the associated methods of test for the verification of their endurance, properties and electrical performance in such applications. The test methods are essentially battery chemistry neutral, i.e. applicable to all secondary battery types. On-grid applications are characterized by the fact that batteries are connected, via power conversion devices, to a regional or nation- or continent-wide electricity grid and act as instantaneous energy sources and sinks to stabilize the grids' performance when randomly major amounts of electrical energy from renewable energy sources are fed into it. Related power conversion and interface equipment is not covered by this part of IEC 61427.
PRODUCTION Design Components	TC 21 - Secondary cells and batteries	03/10/1996	IEC 61434	Secondary cells and batteries containing alkaline or other non-acid electrolytes - Guide to designation of current in alkaline secondary cell and battery standards	This International Standard applies to secondary cells and batteries containing alkaline or other non-acid electrolytes. It proposes a mathematically correct method of current designation which shall be used in future secondary cell and battery standards.

Topic	Technical Committee	Publication Date	Standard	Title	Content
TRANSPORT Requirements and Tests for Safety	TC 35 - Primary cells and batteries	10/04/2019	IEC 62281	Safety of primary and secondary lithium cells and batteries during transport	IEC 62281:2019 specifies test methods and requirements for primary and secondary (rechargeable) lithium cells and batteries to ensure their safety during transport other than for recycling or disposal. Requirements specified in this document do not apply in those cases where special provisions given in the relevant regulations.
OPERATION Requirement and Test **Industrial and Stationary Applications**	TC 21 - Secondary cells and batteries	13/02/2017	IEC 62619	Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for secondary lithium cells and batteries, for use in industrial applications	IEC 62619:2017 specifies requirements and tests for the safe operation of secondary lithium cells and batteries used in industrial applications including stationary applications. The following are some examples of applications that utilize cells and batteries under the scope of this document. - Stationary applications: telecom, uninterruptible power supplies (UPS), electrical energy storage system, utility switching, emergency power, and similar applications. - Motive applications: forklift truck, golf cart, auto guided vehicle (AGV), railway, and marine, excluding road vehicles. Since this document covers batteries for various industrial applications, it includes those requirements, which are common and minimum to the various applications. Electrical safety is included only as a part of the risk analysis. In regard to details for addressing electrical safety, the end use application standard requirements have to be considered. This document applies to cells and batteries. If the battery is divided into smaller units, the smaller unit can be tested as the representative of the battery. The manufacturer clearly declares the tested unit. The manufacturer may add functions, which are present in the final battery to the tested unit.

Topic	Technical Committee	Publication Date	Standard	Title	Content
OPERATION Safety Requirement and Test **Energy Storage Systems**	TC 21 - Secondary cells and batteries	27-03-2020	IEC 63056	Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for secondary lithium cells and batteries for use in electrical energy storage systems	IEC 63056:2020 specifies requirements and tests for the product safety of secondary lithium cells and batteries used in electrical energy storage systems with a maximum DC voltage of 1 500 V (nominal). Basic safety requirements for the secondary lithium cells and batteries used in industrial applications are included in IEC 62619. This document provides additional or specific requirements for electrical energy storage systems. Since this document covers batteries for various electrical energy storage systems, it includes those requirements which are common and minimum to the electrical energy storage systems. Examples of appliances that are within the scope of this document are: • telecommunications, • central emergency lighting and alarm systems, • stationary engine starting, • photovoltaic systems, • home (residential) energy storage systems (HESS), and • large energy storage: on-grid/off-grid. This document applies to cells and batteries for uninterruptible power supplies (UPS). This document does not apply to portable systems 500 Wh or below, which are covered by IEC 61960-3.

Topic	Technical Committee	Publication Date	Standard	Title	Content
DESIGN OPERATION MAINTENANCE	SASB/SCC21 - SCC21 - Fuel Cells, Photovoltaics, Dispersed Generation, and Energy Storage	05/09/2019	IEEE 2030.2.1	IEEE Guide for Design, Operation, and Maintenance of Battery Energy Storage Systems, both Stationary and Mobile, and Applications Integrated with Electric Power Systems	Application of this standard includes: (1) Stationary battery energy storage system (BESS) and mobile BESS. (2) Carrier of BESS, including but not limited to lead acid battery, lithium-ion battery, flow battery, and sodium-sulfur battery. (3) BESS used in electric power systems (EPS). Also provided in this standard are alternatives for connection (including DR interconnection), design, operation, and maintenance of stationary or mobile BESS used in EPS. Introduction, overview, and engineering issues related to the BESS are given.

Other standard drafted from US and Japanese Certification Body is been summarized.

Underwriters Laboratories (UL)
Safety
UL-1642, 5th Edition(link is external): Standard for Lithium Batteries
UL-9540, 2nd Edition(link is external): ANSI/CAN/UL Standard for Energy Storage Systems and Equipment

Testing
UL-9540A, 4th Edition(link is external): ANSI/CAN/UL Standard for Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems
UL-1973, 2nd Edition(link is external): ANSI/CAN/UL Standard for Batteries for Use in Stationary, Vehicle Auxiliary Power and Light Electric Rail (LER) Applications
UL-1974, 1st Edition(link is external): ANSI/CAN/UL Standard for Evaluation for Repurposing

Batteries
Japanese Standards Association (JSA)
JIS C 8715-2(link is external): Secondary Lithium Cells and Batteries for Use in Industrial Applications - Part 2: Tests and requirements of safety

8.4 Open issues and proposals for valorization of second life Li-Ion batteries in standard

Two IEC technical committees have been assigned the task of developing the required standards:

- IEC/TC 21- Secondary cells and batteries
- IEC/TC 35- Primary cells and batteries

Standards mentioned previously could be used as reference standard for second life Li-Ion batteries in hybrid systems, however they shall be improved for this new field.

IEC 62620 (RD-30) specifies marking, tests and requirements for batteries used in industrial application, and it could be used as a reference standard. Nevertheless, “when there exists an IEC standard specifying test conditions and requirements for cells used in special applications and which is in conflict with this standard, the former takes precedence”. Therefore, if a standard were to be redacted for hybrid system application in future, this will take precedence.

In Photovoltaic application, IEC 61427-1 (RD-31) and IEC 61427-2 (RD-32) are references standards. Regarding the matter, a better effort could be made to define batteries operating region. Indeed:

“The temperature range during operation experienced by the battery at the site is an important factor for the battery selection and expected lifetime. Manufacturers’ recommendations for operating temperatures and humidity shall be observed. In the

absence of such information, operating temperatures and humidity may be those shown in Table 2"

However, there is no range for Lithium-ion batteries.

Table 2 – Limit values for operating conditions of batteries for photovoltaic applications

Battery type	Temperature range °C	Humidity %
Lead-acid	-15 to +40	< 90
Nickel-cadmium (standard electrolyte)	-20 to +45	< 90
Nickel-cadmium (high density electrolyte)	-40 to +45	< 90
Nickel-metal hydride	-20 to +45	< 90
Lithium-ion and other electro chemistries	To be verified with the battery manufacturer	To be verified with the battery manufacturer

Instead, requirements and test in PV applications On Grid do not need any improvements. Indeed:

"The test methods are essentially battery chemistry neutral, i.e. applicable to all secondary battery types"

Similarly, requirements and test for safety during transport (RD-33) don't need any improvements. Thus, the nature of the application does not influence requirements and test.

In conclusion, it is proposed to uncouple end-users by cell manufacturer and battery system manufacturer, defining a new operating region for second life Li-Ion batteries in hybrid systems. Indeed, they are related in IEC 62619 (RD-23) and IEC 63056 (RD-24):

"The cell manufacturer shall provide recommendations about current, voltage and temperature limits so that the battery system manufacturer may ensure proper design and assembly"

"Lithium-ion cells shall always be operated within the operating region values and the storage conditions specified by the manufacturer"

8.5 Policy about Li-Ion Second Life Batteries

Electrification is set to be one of the main technological pathways to reach carbon neutrality. Batteries will be one of the key enablers for this transition given the important role they play in stabilizing the power grid.

In this context, in May 2018, the **European Commission** adopted the *Strategic Action Plan on Batteries* (RD-25). This brought together a set of measures to support national, regional

and industrial efforts to build a battery value chain in Europe, embracing raw materials' extraction, sourcing and processing, battery materials, cell production, battery systems, as well as re-use and recycling.

"By 2030, it is expected that around 55 percent of electricity consumed in the EU will be produced from renewables (up from the current level of 29 percent). For an effective integration of this renewable electricity, the whole range of energy storage technologies will be required, including batteries. By providing the opportunity to store electricity temporarily and to feed it back into the grid, batteries can help society make better use of variable and decentralized renewable energy sources like solar power."

Therefore, storage for renewable energy will be a major driver of battery demand.
The Commission's objective is that the EU becomes an industrial leader and increases its strategic autonomy in the battery sector, across the value chain.

"The EU budget is already providing important funding opportunities to support research and innovation in batteries. The EU's Framework Programme for Research and Innovation for 2014-2020, Horizon 2020, has granted EUR 1.34 billion to projects for energy storage on the grid. In 2019, Horizon 2020 added a call to fund, under the ***European Battery Alliance*** (RD-30)*, battery projects worth EUR 114 million. This will be followed by a call in 2020 amounting to EUR 132 million, covering batteries."*

In addition, demonstration projects and pilots are important to test out the new technologies in near-market conditions, prior to ramping up production on a commercial scale.

"To support first-of-a-kind commercial scale energy demonstration projects, the European Investment Bank (EIB) provides loans, guarantees and equity-type funding through the InnovFin Energy Demo Projects (EDP) facility. The facility has already provided one loan of EUR 52.5 million to a demonstration plant in Sweden for the manufacturing of advanced Li-ion cells for batteries in transport, stationary storage and industry. Several battery industry projects in Croatia, France, Greece and Sweden have also benefited from support under the European Fund for Strategic Investments. ***In the next Multiannual Financial Framework, the new InvestEU Fund is expected to bring together under one roof the existing financial instruments which will make EU support more efficient and more flexible also in the field of batteries."***

The Innovation Fund established by the EU's Emission Trading Scheme should provide around EUR 10 billion in the period 2020-2030 to support pre-commercial demonstration projects in low-carbon technologies, including energy storage.

The EU labour force is highly qualified but sufficient specialized battery-related skills are still lacking, especially on applied process design and cells manufacturing. Action at EU and Member State level is being taken to help to close this skills gap and make Europe an attractive location for world-class experts in batteries development and production, to design and implement training, reskilling, and upskilling programmes.
Furthermore, the circular economy is one of the Commission's objectives. Re-use of batteries in stationary applications can reduce environmental impacts over the life- cycle. **The Commission has signed an Innovation Deal on batteries to investigate whether current legislation at the EU or Member State level allows the re-use of batteries**.

The Commission presented the integrated *Strategic Energy Technology Plan* (RD-19) (SET Plan) in 2007 and revised it in 2015. The SET Plan contains ten key actions, four of which are relevant to energy storage.

A supportive regulatory framework and more predictable market conditions can increase the demand for energy storage, decrease the investment risk and, consequently, attract private investments in technological development. The "Clean Energy for All Europeans (RD-30)" package proposed at the end of 2016 (completed in 2018) aimed to facilitate the transition to clean energy. In particular, the proposals relating to the electricity market aim to allow greater flexibility to accommodate a growing percentage of energy from renewable sources. These proposals contain provisions aimed at removing legislative obstacles to storage. The package comprises eight pieces of legislation.

Especially one of these (*Directive of the European Parliament and of the Council on common rules for the internal market in electricity* (RD-30)), concerns energy storage. The Directive on common rules for the internal market in electricity establishes common rules for the generation, transmission, distribution, storage and supply of electricity, together with consumer protection provisions, in order to create electricity markets that are truly integrated, competitive, consumer-centric and flexible, fair and transparent in Europe. The 2018 directive also defines, for the first time, "**energy storage**" as: "*the postponement of the final use of electricity to a time after its generation or the conversion of electricity into a form of energy that it can be stored* ".

So far, the absence of a common regulatory approach has led to a difference in the way Member States treat storage in the energy system, especially for network fees. The current *common rules for the internal electricity market* (RD-30), adopted in 2009, require Member States to apply tariffs for access to electricity grids in a transparent and non-discriminatory way. However, they do not address the specific case of energy storage. In some Member States (Austria, Germany, Finland, and the Netherlands), storage system owners have to pay network fees twice, as consumers and producers. This double taxation has hampered investments in energy storage (Finland and the Netherlands are reviewing their policy to resolve this issue).

9 CLC and hydrogen systems in buildings: legislative, standard and policy analysis

This chapter explains the needed for the installation of an equipment that use hydrogen in a residential building. This kind of devices must fulfil the safety mandatory requirement provided for the product that are to get in the market. A deep analysis has been conducted for the SCORES test sites in France and Austria.

9.1 Legislation about CLC and hydrogen in buildings

9.1.1 European legislative framework for new products

This paragraph lay down the current European legislative framework for new product not yet on the market (like CLC, Li-Ion Batteries).

First point is the relation within SCORES prototype and the **product safety directive 2001/95/EC**.

After the regulation framework has been defined and authorities that survey the market to assure that the product put in the market or that cross the border are compliant within European harmonized directive, especially from the safety point of view.

It is necessary to define these main issues to understand the procedure and the action required to SCORES product, in order to be installed in the demo sites, in the residential area of Agen and Gleidorf.

9.1.2 Product safety

In the absence of Community provisions, horizontal legislation of the Member States on product safety, imposing a general obligation on economic operators to market only safe products, might differ in the level of protection afforded to consumers. Such disparities, and the absence of horizontal legislation in some Member States, would be liable to create barriers to trade and distortion of competition within the internal market.

The Community legislation sets out safety requirements covering only certain risks or categories of risks, regarding the products concerned the obligations of economic operators in respect of these risks are those determined by the provisions of the specific legislation, Directive 2001/95/EC should apply to the other risks not covered by other specific European legislation for the general safety requirement.

In the absence of specific regulations and when the European standards established under mandates set by the Commission are not available or recourse is not made to such standards, the safety of products should be assessed taking into account in particular national standards transposing any other relevant European or international standards, Commission recommendations or national standards, international standards, codes of good

practice, the state of the art and the safety which consumers may reasonably expect. In this context, the Commission's recommendations may facilitate the consistent and effective application of this Directive pending the introduction of European standards or as regards the risks and/or products for which such standards are deemed not to be possible or appropriate.

Appropriate independent certification recognized by the competent authorities may facilitate proof of compliance with the applicable product safety criteria.

The additional obligations of producers should include the duty to adopt measures commensurate with the characteristics of the products, enabling them to be informed of the risks that these products may present, to supply consumers with information enabling them to assess and prevent risks, to warn consumers of the risks posed by dangerous products already supplied to them.

Member States have designated authorities responsible for monitoring product safety and have powers to take appropriate measures, including the power to impose effective, proportionate, and dissuasive penalties, and ensure appropriate coordination between the various designated authorities.

The CLC and Li-Ion Batteries cannot consider safe product as defined by Directive 2001/95:

safe product shall mean any product which, under normal or reasonably foreseeable conditions of use including duration and, where applicable, putting into service, installation and maintenance requirements, does not present any risk or only the minimum risks compatible with the product's use, considered to be acceptable and consistent with a high level of protection for the safety and health of persons.

For this reason, it is necessary an assessment that verify the risk about and the ‘dangerous product’.

9.1.3 Market and border surveillance

Each Member State has to create its **market surveillance authorities**, in force of REGULATION (EC) No 765/2008, **in order to ensure that products covered by Community harmonization legislation** which, when used in accordance with their intended purpose or under conditions which can be reasonably foreseen and when properly installed and maintained**, are liable to compromise the health or safety of users**, **or which otherwise do not conform to applicable requirements set out in Community harmonization legislation are withdrawn or their being made available on the market is prohibited or restricted**.

The authorities in charge of external border controls shall suspend release of a product for free circulation on the Community market when any of the following findings are made during the checks:

> (a) the product displays characteristics which give cause to believe that the product, when properly installed, maintained and used, presents a serious risk to health, safety, the environment or any other public interest;

(b) the product is not accompanied by the written or electronic documentation required by the relevant Community harmonization legislation or is not marked in accordance with that legislation;
(c) the CE marking has been affixed to the product in a false or misleading manner.
The authorities in charge of external border controls shall immediately notify the market surveillance authorities of any such suspension.

Where the **market surveillance authorities find that a product presents a serious risk, they shall take measures to prohibit that product from being placed on the market** and shall require the authorities in charge of external border controls to include the following endorsement on the commercial invoice accompanying the product and on any other relevant accompanying document or, where data processing is carried out electronically, in the data-processing system itself:
'Dangerous product — release for free circulation not authorized — Regulation (EC) No 765/2008'.

Where the market surveillance authorities find that a product does not comply with Community harmonisation legislation, they shall take appropriate action, which may, if necessary, include prohibiting the product's being placed on the market. Where placing on the market is prohibited pursuant to the first subparagraph, the market surveillance authorities shall require the authorities in charge of external border controls not to release the product for free circulation and to include the following endorsement on the commercial invoice accompanying the product and on any other relevant accompanying document or, where data processing is carried out electronically, in the data-processing system itself:
'Product not in conformity — release for free circulation not authorized — Regulation (EC) No 765/2008'.

The **CE marking** shall be affixed only by the manufacturer or his authorized representative.
By affixing or having affixed the CE marking, the manufacturer indicates that he takes responsibility for the conformity of the product with all applicable requirements set out in the relevant Community harmonization legislation providing for its affixing.
The CE marking shall be the only marking which attests the conformity of the product with the applicable requirements of the relevant Community harmonization legislation providing for its affixing.

In the case of **products posing a serious risk, the competent authorities shall with due dispatch take the appropriate measure**. The existence of a serious risk shall be determined by the Member States, assessing each individual case on its merits and taking into account the guidelines referred to in point 8 of Annex II of Directive 2001/95/EC.

9.1.4 Duty of manufacturers

In this paragraph has been summarized the main duty of a manufacturer when places a new product on the market.

When placing their products on the market, manufacturers shall ensure that they have been designed and manufactured in accordance with the requirements set out in the relevant part of the legislation.

Manufacturers shall draw up the required technical documentation and carry out the conformity assessment procedure applicable or have it carried out. Where compliance of a product with the applicable requirements has been demonstrated by that procedure, manufacturers shall draw up an EC declaration of conformity and affix the conformity marking.

Manufacturers shall keep the technical documentation and the EC declaration of conformity for ... [period to be specified in proportion to the lifecycle of the product and the level of risk] after the product has been placed on the market.

Manufacturers shall ensure that procedures are in place for series production to remain in conformity. Changes in product design or characteristics and changes in the harmonized standards or in technical specifications by reference to which conformity of a product is declared shall be adequately considered.

When deemed appropriate about the risks presented by a product, manufacturers shall, to protect the health and safety of consumers, carry out sample testing of marketed products, investigate, and, if necessary, keep a register of complaints, of non-conforming products and product recalls, and shall keep distributors informed of any such monitoring.

Manufacturers shall ensure that their products bear a type, batch or serial number or other element allowing their identification, or, where the size or nature of the product does not allow it, that the required information is provided on the packaging or in a document accompanying the product.

Manufacturers shall indicate their name, registered trade name or registered trademark and the address at which they can be contacted on the product or, where that is not possible, on its packaging or in a document accompanying the product. The address must indicate a single point at which the manufacturer can be contacted.

Manufacturers shall ensure that the product is accompanied by instructions and safety information in a language which can be easily understood by consumers and other end-users, as determined by the Member State concerned.

Manufacturers who consider or have reason to believe that a product which they have placed on the market is not in conformity with the applicable Community harmonization legislation shall immediately take the necessary corrective measures to bring that product into conformity, to withdraw it or recall it, if appropriate. Furthermore, where the product presents a risk, manufacturers shall immediately inform the competent national authorities of the Member States in which they made the product available to that effect, giving details, in particular, of the non-compliance and of any corrective measures taken.

Manufacturers shall, further to a reasoned request from a competent national authority, provide it with all the information and documentation necessary to demonstrate the

conformity of the product, in a language which can be easily understood by that authority. They shall cooperate with that authority, at its request, on any action taken to eliminate the risks posed by products which they have placed on the market.

9.1.5 Obstacle to free movement of products between European States

Regulation (EC) 764:2008 lays down the rules and procedures to be followed by the competent authorities of a Member State when taking or intending to take a decision which would hinder the free movement of a product lawfully marketed in another Member State.

This Regulation applies only to products or features of products which are not subject to Community harmonization measures intended to eliminate obstacles to trade between Member States resulting from the existence of divergent national technical rules. The provisions of such harmonisation measures are often exhaustive, in which case Member States may not prohibit, restrict or impede the placing on the market in their territories of products complying with those measures. **Some Community harmonization measures, however, permit Member States to impose additional technical conditions on the placing of a product on their market.**

The mutual recognition of a conformity assessment body is guaranteed by article 5: **Member States shall not refuse certificates or test reports issued by a conformity-assessment body accredited for the appropriate field of conformity-assessment activity** in accordance with Regulation (EC) No 765/2008 on grounds related to the competence of that body.

9.2 European directive to follow to guarantee the safety of the CLC manufacturing and installation

The follow directive should be applied to guarantee the safety.

Pressure equipment referred to in Article 4(1) shall be classified by category in accordance with Annex II, according to an ascending level of hazard.

- Directive 2014/64/EU – Pressure Equipment
- Regulation (EU) 2016/426 – Gas Appliances
- Directive 2014/34/EU – ATEX
- Directive 2014/35/EU - Low voltage

9.2.1 Pressure Equipment Directive

Eligibility

The CLC shall satisfy the essential safety requirements set out in Annex I of PED Directive, it can be considered, according to article 4 (2): “assemblies intended for generating steam or

superheated water at a temperature higher than 110 °C comprising at least one item of fired or otherwise heated pressure equipment presenting a risk of overheating".

Piping and safety and pressure accessories incorporated into the assembly are included into the PED safety requirements.

Conformity to essential safety requirements

Pressure equipment or assemblies which are in conformity with harmonized standards or parts thereof the references of which have been published in the Official Journal of the European Union shall be presumed to be in conformity with the essential safety requirements covered by those standards or parts thereof, referred to in Annex I of Directive 2014/64/EU.

The materials used for the manufacture of pressure equipment or assemblies which are in conformity with European approvals for materials, the references of which have been published in the Official Journal of the European Union, shall be presumed to be in conformity with the applicable essential safety requirements as defined in Annex I of Directive 2014/64/EU.

9.2.2 Gas Appliance Directive

Eligibility

This Regulation could be applied to hydrogen fuel because to deal with the appliances burning gaseous fuels used for cooking, refrigeration, air-conditioning, space heating, hot water production, lighting or washing, and also forced draught burners and heating bodies to be equipped with such burners and to safety devices, controlling devices or regulating devices and sub-assemblies thereof, designed to be incorporated into an appliance or to be assembled to constitute an appliance (fittings).

Conformity to essential safety requirements

When placing their appliances or fittings on the market or when using the appliances for their own purposes, manufacturers shall ensure that they have been designed and manufactured in accordance with the essential requirements set out in Annex I.

Manufacturers shall draw up the technical documentation referred to in Annex III ('technical documentation')

9.2.3 ATEX Directive

Conformity to essential safety requirements

When placing their appliances or fittings on the market or when using the appliances for their own purposes, manufacturers shall ensure that they have been designed and manufactured in accordance with the essential requirements set out in Annex I.

Manufacturers shall draw up the technical documentation referred to in Annex III ('technical documentation')

9.2.4 Low Voltage Directive

Eligibility

This Regulation could be applied to hydrogen fuel because to deal with the appliances burning gaseous fuels used for cooking, refrigeration, air-conditioning, space heating, hot water production, lighting or washing, and also forced draught burners and heating bodies to be equipped with such burners and to safety devices, controlling devices or regulating devices and sub-assemblies thereof, designed to be incorporated into an appliance or to be assembled to constitute an appliance (fittings).

Conformity to essential safety requirements

When placing their appliances or fittings on the market or when using the appliances for their own purposes, manufacturers shall ensure that they have been designed and manufactured in accordance with the essential requirements set out in Annex I.

Manufacturers shall draw up the technical documentation referred to in Annex III ('technical documentation')

Harmonized standard

The reference standard for the installation of heating systems in civil buildings must comply with several legislative requirements related to:

- Energy efficiency of buildings, energy certification (EPBD Directive)
- Environmental impact
- Safety in the workplace
- Hot water pressure devices
- Pressure devices (PED)
- Fire prevention
- Electrical security
- Water treatment in the plants
- Fuel supply lines
- Fuel storage

Each of the aforementioned areas may be referred to one or more public bodies that have the function of checking, authorizing or verifying what has been installed.

This report does not intend to provide a complete picture, but focuses on the main legislation on installation of thermal systems in residential buildings and two specific aspects:
- pressurized equipment
- production and transfer of hydrogen

9.2.5 Applicable legislation in France

Legislation code about the build of the houses

The French reference law for building construction is "**Code de la construction et de l'habitation**", in this code there are the general principles for building activities and for the relationships between stakeholders and buildings (including owners, buyers, tenants, builders, public authorities, etc).

The code is split in two main sections:
- the legislative section (article with L before the number)
- the regulatory section (article with R before the number)

Article L111-4 (Modified by Law No. 2000-1208 of December 13, 2000 - Article 74 JORF, December 14, 2000)
This article deal with the general construction rules applicable to residential buildings, the maintenance measures to ensure compliance with safety standards and the demolition of the buildings, as well as the means to justify the fulfilment of this maintenance obligation are established by decree in the Council of State. The provisions of this text are automatically replaced by the contrary or divergent provisions of the departmental and municipal regulations.

Another important section for air conditioning systems (chauffage des immeubles) are on the articles L134 that deal with:

- Section 1 : Energy performance Audit. (Articles L134-1 à L134-5)
- Section 2 : Safety on the gas systems (Article L134-6)
- Section 3 : Safety of the electrical systems (Article L134-7)

The technical verifications on buildings and installed equipment are carried out according to the article **R123-43**: "Manufacturers, installers and operators are each required to ensure that facilities or equipment are established, and maintained in accordance with the provisions of these regulations. For this purpose, they carry out, during construction and periodically during operation, the necessary verifications by the organizations or persons authorized under the conditions laid down by the Minister of the Interior. The control exercised by the administration or the security committees does not relieve them of their personal responsibilities. The silence kept for more than four months on the application for approval submitted pursuant to the preceding paragraph is deemed to be a rejection decision."

From "*Code de la construction et de l'habitation*" technical decrees were issued.
These decrees indicate the specific requirements that thermal systems must have for French homes.
The *"Arrêté du 23 juin 1978 modifié, relatif aux installations fixes de production de chaleur et à l'alimentation en eau chaude sanitaire des bâtiments d'habitation, de bureaux ou recevant*

du public". (Last modification: December 15, 2006)[2] is the most important because reports the technical rules and the requirements for the installation in the building of gas boilers with a capacity exceeding 70 kW.

Waiting for specific legislation that sets requirements on innovative heating systems, the boiler regulations can be a useful point of reference. The ordinance prescribes the position of the boiler rooms, the location of the equipment and the installation of the systems

The articles of the title I describe in detail the characteristics that must have the boiler room:

- Art. 3 : the position of boiler room
- Art. 4 : fixes the constructive characteristics of the room
- Art. 5 : fixes openings and passive protection requirements from fire
- Art. 6 : fixes the performance requirements of temperature and noise level that the room where the thermal power plant is located will have to respect
- Art 7: fix the spaces necessary for maintenance and access to the equipments
- …
- Art 14: defines the requirements for the lighting system and other electrical circuits
- Art. 18-19: define location and requirements for the chimney, which can be taken as a reference for the CLC expulsion of hot air produced by the oxidation process.
- Art. 20 active fire-safety measures (portable fire extinguishers, sprinkler systems)

Title III refers to heating systems with power below 70 kW, it should be noted that the thermal power refers to the sum of the thermal power of all the generators of the system.

Article. 40 indicates that any exceptions to the provisions of this decree may be granted by joint decision by the Ministries of Industry and the Environment

French legislation about PED

France has implemented the PED recast directive with:

Décret no 2015-799 du 1er juillet 2015 relatif aux produits et équipements à risques
Official publication: Journal Officiel de la République Française (JORF); Publication date: 2015-07-03

Arrêté du 1er juillet 2015 relatif aux organismes habilités à réaliser les évaluations de la conformité et les opérations de suivi en service des produits et équipements à risques
Official publication: Journal Officiel de la République Française (JORF); Publication date: 2015-07-03

Fire safety in building's thermal systems in France

The Code of Housing and Construction, the Labor Code, and specific laws are the basis for the Fire regulation in France. Fire safety regulation is a set of both local and European

2 https://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000000643230&categorieLien=cid#LEGISCTA000006128768

standards and decrees as EU directives are gradually getting integrated at the national and local levels.

Fire prevention competencies are centralized in different ministries like the Interior, Housing, Labor, Environment and Equipment ministries. These various agencies set the minimum compliance requirements for design, construction, and the management of buildings that prevent fires and ensure safety.

Regulatory documents classify buildings and indicate their fire protection requirements for each building type, depending on the risks inherent to that kind of building.

The mail law for fire safety in the buildings in France is “Arrêté du 25 juin 1980 portant approbation des dispositions générales du règlement de sécurité contre les risques d'incendie et de panique dans les établissements recevant du public (ERP).(last modification 1st January 2018)[3]
This decree is not written for residential buildings, but for buildings open to the public, however it provides important indications for fire safety in thermal systems of residential buildings.

An important indication is provided on products without CE marking or certification.

In particular, article GN 14 states: “§ 1. Where compliance with a French standard or a non-harmonized European standard is required by this Regulation, this requirement does not apply to products manufactured in accordance with the standards, technical specifications or manufacturing processes of a Member State of the European Community or another State Party to the Agreement establishing the European Economic Area or Turkey which provide an equivalent level of fire protection. However, a product may be refused marketing or withdrawn from the market if it does not provide this level of protection. These decisions are preceded by a contradictory procedure.

§ 2. Where product certification, such as admission to the NF Mark, is required by this Regulation, this requirement does not apply to products whose equivalence with the level of protection against fire has been certified in a Member State of the European Community or of another State Party to the Agreement establishing the European Economic Area or Turkey. This equivalence is assessed in particular in terms of suitability for use in the fire protection systems mentioned in this Regulation. The certifying body must be accredited according to the NF EN 45011 standard by a signatory body of the European Multilateral Agreement adopted within the framework of the European coordination of accreditation bodies.

§ 3. Where products are subject to CE marking, any evidence of conformity other than that allowing the marking referred to in this Regulation ceases to be due as from the date of entry into force of this marking obligation.

[3] https://www.legifrance.gouv.fr/affichTexte.do;?cidTexte=LEGITEXT000020303557

During the so-called coexistence period during which producers may use the French technical specifications or the European technical specifications, proof of conformity of these products by reference to the French technical specifications is allowed.

§ 4. When they have been carried out on the basis of a common reference system, the tests carried out by the laboratories of other Member States of the European Community or of States Parties to the Agreement establishing the European Economic Area or of Turkey, accredited according to standard NF EN ISO / CEI 17025 by a signatory body of the European Multilateral Agreement made within the framework of the European coordination of accreditation bodies are accepted in the same way as the tests carried out by accredited French laboratories."

Chapter V (articles with the CH code) of the decree applies to:
- heating
- ventilation, air conditioning
- production and distribution of domestic hot water
- cooling (production, distribution, use).

Chapter V is structured in the follow sections (in bold the most relevant for Scores scopes):

- **Section 1: general information**
- **Section 2: installation of heat production equipment**
- **Section 3: fuel storage**
- Section 4: propane and butane distribution in liquid phase (repealed)
- **Section 5: hot water, steam and hot air heating**
- Section 6: domestic hot water
- Section 7: Air handling and ventilation
- Section 8: independent devices for the heating productions
- **Section 9: maintenance and verifications**

Art. CH 2 reports the conformity aspects of the appliances, in particular for gas appliances refer to article GZ 26 which indicates that gas appliances that do not fall within the scope of the Decree of 12 August 91, which implemented Directive 90/396 / EEC (replaced today by regulation 2016/426 on appliances burning gaseous fuels), are allowed if:

- They have CE marking for industrial thermal equipment according to the directive 89/392 concerning the machines
- Prior approval of the Ministry responsible for gas safety (excluding this alternative for gas appliances with rated heat not exceeding 5 kW)

Of course, it refers to plants fuelled with gaseous fuels (natural gas, methane, LPG), but does not consider hydrogen, for which there is currently no regulation for buildings' heating systems.

Article CH 3 indicates that plants using gaseous fuel must comply with the provisions of Chapter IV which will be referred to in the continuation of the discussion.

Of particular importance for the analysis under way, although not 100% relevant, is the Chapter VI (pre-GZ article code), which concerns the plants of combustible gas and liquefied hydrocarbons.

The importance of the correspondence between combustible gases and hydrogen is sanctioned by the similarity that these types of plants have for motor vehicles.

Of particular importance for the installation is the declaration of conformity that must be issued by the installer at the end of the construction of the gas system, the tests of mechanical strength and sealing are now foreseen according to the Article GZ 19.

The Section 7 deals with the compliance, maintenance, and verification of gas installations

9.2.6 Applicable legislation in Austria

Construction sector laws and regulations in Austria are within the competence of the nine provinces (Bundesländer).

The most important laws for our scope are:

- Construction law (Bauordnungsgesetz)
- Technical requirements in Construction (Bautechnikgesetz)
- Technical requirements in Energy (Energietechnikgesetz)
- Heating and combustible materials directive (Heizanlagen- und Brennstoffverordnung)
- 6 OIB guidelines – Austrian Institute of Construction Engineering (OIB): mechanical stability; safety in case of fire; Hygiene, health & environment; protection against noise; energy economy

Some countries, such as Burgenland, Styria and Vorarlberg, have a building law. Countries such as Lower Austria and Tyrol, as well as the city of Vienna have a building code. Others, such as Salzburg, use several laws at the same time (Basic Law on Building Law, Building Police Act, Building Technology Act, Decree for Buildings without Building Site Declaration, etc.)[4]

In 2008 most provinces joint a nation-wide effort in harmonizing the regional construction laws, in particular in the field of technical construction norms and standards.

[4] http://www.bauordnungen.de/html/osterreich.html

Legislation about the build of the houses in Styria

In this report is detailed the **Styria Building Law** (**Steiermärkisches Baugesetz** from 07.07.2017)[5]

To receive the authorization to construct a building, the procedure detailed in Part III have to be followed (articles from 17 to 33 describe that).
In articles 19, 20, 21 are described the three procedures provided for different kind of construction activity:

- Building permit projects: projects subject to approval of public authority (art. 19)
- Notifiable projects: projects subject to notification to public authority (art. 20)
- Building permit-free projects: projects no subject to approval or notification (art.21)

For the installation of CLC equipment, should be verified if is necessary the application of:

- art. 19 (point 2) “Usage changes that may affect the strength, fire safety, hygiene, safety of structures or their parts or affect the neighbouring rights or if provisions of the applicable spatial planning act, the zoning plan or the zoning plan can be affected”. That could be necessary if are the design require change of use of spaces.
- Art.20 (point 1d) if the installation of CLC require the build of an outbuilding
- Art 21 (point 1) if the installation of CLC equipment can be assimilated to a fuel storage or a solar o photovoltaic system.

At the end of construction, the authority can verify the compliance with building regulations. (art. 37) For this purpose, the organs of the authority shall be allowed access to the property and to all parts of the structure. The client and the site manager are obliged to provide the authorities with all necessary information and insight into all relevant documents.
In addition, the authority may order load tests and investigations on heat and sound insulation and demand proof of the ability of the construction products to be installed.

[5] https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=LrStmk&Gesetzesnummer=20000070

Other important points that could involve a CLC installation are:

- Art 60 Exhaust gases from fireplaces “Exhaust fumes from fireplaces shall be discharged to the outside, taking into account the nature of the fireplace and the fuel, so as not to endanger the safety and health of persons and not unduly prejudice them. Exhaust systems shall be designed so that they can be easily checked and cleaned.
- Art. 64 Protection against dangerous emissions: “Structures shall be designed and constructed in their entirety in such a way that they do not endanger the health of the user of the building, such as pollution. As dangerous gases, particles or rays caused. If, due to the intended use of the structure, emissions in dangerous concentrations are not excluded (eg in garages), structural or other measures must be taken to avoid health impairments. As measures z. B. special ventilation and the establishment of warning devices may be required.
- Art. 68: Storage of hazardous substances: “Structures or parts of buildings where hazardous substances are stored must be designed in such a way as not to endanger the life and health of persons or endanger the environment through the escape or ingress of these substances into the soil.”

Legislation about thermal plants in the houses in Styria

The combustion plants in the buildings have to comply the Styrian Combustion Plant Act (2016 Bestimmungen des Steiermärkischen Feuerungsanlagengesetzes).

This law deals with the small boiler with maximum nominal heat power 400 kW.

To put in the market a central heating appliance is required in the CE marking. For construction products for which a harmonized standard does not yet exist and for which no European Technical Assessment (ETA) has been issued, Member States may continue to maintain national identification and approval systems. In Austria, there is the ÜA sign for this purpose. For which construction products a ÜA mark is required, ÖA is specified in the building material list. The basis of the ÜA mark is ÖNORMEN, other technical regulations or a building permit granted by the OIB (BTZ).

The law provide also some operative rules about operations, maintenance and initial and periodic check of the plant (Art 19-22).

In section 6 are provided all the information for inspection of the heating system.

Austrian legislation about PED

The Pressure Equipment Directive, applies to the design, manufacture and conformity assessment of pressure equipment and assemblies with a maximum allowable pressure greater than 0.5 bar.

Technical requirements and classification according to an ascending level of hazard, depending on pressure, volume or nominal size, the fluid group and state of aggregation, as well as conformity assessment procedures are laid down and required by the Directive.

Hydrogen is a fluid which falls under Group 1. Group 1 consists of dangerous fluids (flammable, toxic and/or oxidizing). As a result, a large part of the equipment for H2 production, storage and distribution must meet the technical requirements set out in the Pressure Equipment Directive (PED).

Austria has implemented the PED recast directive with:

BMWFW: Verordnung des Bundesministers für Wissenschaft, Forschung und Wirtschaft, mit der die Druckgeräteverordnung geändert wird (Änderung der Druckgeräteverordnung)
Official publication: Bundesgesetzblatt für die Republik Österreich (BGBl.); Number: II Nr. 336/2014; Publication date: 2014-12-10

Bundesgesetz, über die Sicherheit von unter Druck stehenden Geräten (Druckgerätegesetz)
Official publication: Bundesgesetzblatt für die Republik Österreich (BGBl.); Number: I Nr. 161/2015; Publication date: 2015-12-28

Verordnung des Bundesministers für Wissenschaft, Forschung und Wirtschaft über Druckgeräte und einfache Druckbehälter (Duale Druckgeräteverordnung – DDGV)
Official publication: Bundesgesetzblatt für die Republik Österreich (BGBl.); Number: II Nr. 59/2016; Publication date: 2016-03-09

Pressure equipment (steam boilers, pressure vessels and pipelines) with high-risk potential are in accordance with the provisions of § 3 of the Pressure Equipment Surveillance Ordinance (DGÜW-V), BGBl. II No. 420/2004, on the occasion of the commissioning of a "first audit" and during operation "recurrent examinations (supervision)" by boiler testing stations to undergo. The demarcation of pressure equipment with high-risk potential
is determined with § 4 DGÜW-V. The operator of a pressure device with high-risk potential has for the tests and Investigations to commission a boiler testing center. The applicable for the respective printing device monitoring measures and revision periods for the periodic investigations shall be determined by the boiler testing centre on the first external inspection.

9.3 Hydrogen legislation

The most significant EU legislative act impacting stationary power (micro CHP)'s is Regulation (EU) 2016/426. This act, which is directly applicable in all EU Member States and EEA countries contains essential requirements concerning appliances burning gaseous fuels and their fittings and prescribes the obligations of manufacturers, importers and distributors of such appliances and fittings when placing them on the market.[6]

[6] http://www.hylaw.eu/

Directives 2009/73/EC and 2009/72/EC, affect this category of hydrogen applications only indirectly as they set general rules for the transmission, distribution, supply and storage of natural gas and electricity, but impose obligations only on Member States and distribution system operator.

Similarly, Directive 2012/27/EU only indirectly affects this category by setting general measures for the promotion of energy efficiency within the EU.

Regulation (EU) 2016/426 of the European Parliament and of the Council of 9 March 2016 on appliances burning gaseous fuels	This Regulation applies to appliances burning gaseous fuels used for cooking, refrigeration, air-conditioning, space heating, hot water production, lighting or washing, and also forced draught burners and heating bodies to be equipped with such burners and to safety devices, controlling devices or regulating devices and sub-assemblies thereof, designed to be incorporated into an appliance or to be assembled to constitute an appliance (fittings). Article 7 sets the **obligations of manufacturers** which should inter alia: • • ensure that appliances and fittings meet the essential requirements set out in Annex I. • • draw up the technical documentation referred to in Annex III (‘technical documentation’) • • carry out the relevant conformity assessment procedure • • keep the technical documentation and the EU declaration of conformity for 10 years • • ensure that procedures are in place for series production to remain in conformity • • carry out sample testing of appliances made available on the market, • • investigate, and, if necessary, keep a register of complaints, of non-conforming appliances and fittings and recalls of such appliances and fittings, and shall keep distributors informed of any such monitoring. • • ensure that their appliances and fittings bear a type, batch or serial number or other element allowing their identification, and the inscriptions provided for in Annex IV. • • indicate on the appliance their name, registered trade name or registered trademark, and the postal address at which they can be contacted • • ensure that the appliance or fitting is accompanied by instructions and safety information • • ensure that the fitting is accompanied by a copy of the EU declaration of conformity containing, inter alia, instructions for incorporation or assembly, adjustment, operation and maintenance • • take corrective measures necessary to bring that appliance or fitting into conformity, to withdraw it or recall it, if appropriate. • • where the appliance or the fitting presents a risk, immediately inform the competent national authorities giving details, in particular, of the non-compliance and of any corrective measures taken • • provide competent national authority with all the information and documentation necessary to demonstrate the conformity of the appliance. Article 9 sets **obligations for importers** which should inter alia: • • ensure that the appropriate conformity assessment procedure has been carried out • • ensure that the manufacturer has drawn up the technical documentation, that the appliance bears the CE marking and is accompanied by instructions and safety information and that the manufacturer has complied with the requirements set out in Article 7(5) and (6). • • indicate on the appliance their name, registered trade name or registered trademark, and the postal address at which they can be contacted • • ensure that the appliance is accompanied by instructions and safety information in accordance with point 1.5 of Annex I, in a language which can be easily

	understood by consumers and other end-users, as determined by the Member State concerned. • • ensure that the fitting is accompanied by a copy of the EU declaration of conformity containing, inter alia, instructions for incorporation or assembly, adjustment, operation and maintenance in accordance, in a language which can be easily understood by appliance manufacturers, as determined by the Member State concerned. • • ensure that, while an appliance or a fitting is under their responsibility, storage or transport
Directive 2009/73/EC of the European Parliament and of the Council concerning common rules for the internal market in natural gas and repealing Directive 2003/55/EC	Directive 2009/73/EC establishes common rules for the transmission, distribution, supply and storage of natural gas. Its provisions and obligations apply to Hydrogen Gas by virtue of Article 1 (2), which states that the rules established by this Directive for natural gas, including LNG, shall also apply in a non–discriminatory way to biogas and gas from biomass or other types of gas in so far as such gases can technically and safely be injected into, and transported through, the natural gas system. Article 25 establishes the "Tasks of the distribution system operator" which include: ensuring the long-term ability of the system to meet reasonable demands for the distribution of gas […];shall provide any other distribution, transmission, LNG, and/or storage system operator with sufficient information […] as well as to ensure that the system operator does not discriminate between system users or classes of system including, including e.g. when setting rules for the charging of system users, etc Article 32 sets the rules on "Third party access": access to the transmission and distribution system, and LNG facilities shall be based on published tariffs, applicable to all eligible customers, including supply undertakings, and applied objectively and without discrimination between system users.
Directive 2009/72/C of the European Parliament and of The Council of 13 July 2009 concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC	Directive 2009/72/EC establishes common rules for the generation, transmission, distribution and supply of electricity, together with consumer protection provisions. It lays down the rules relating to the organization and functioning of the electricity sector, open access to the market, the criteria and procedures applicable to calls for tenders and the granting of authorizations and the operation of systems. It also lays down universal service obligations and the rights of electricity consumers and clarifies competition requirements. Article 25 establishes the "Tasks of the distribution system operator" which include: ensuring the long-term ability of the system to meet reasonable demands for the distribution of electricity […] as well as to ensure that the system operator does not discriminate between system users or classes of system users including e.g. when setting rules for the charging of system users, etc. Article 25 allows, however to require the distribution system operator to give priority to generating installations using renewable energy sources or waste or producing combined heat and power. Article 32 sets the rules on "Third party access": access to the transmission and distribution system, and LNG facilities shall be based on published tariffs, without discrimination between system users. The transmission or distribution system operator may refuse access where it lacks the necessary capacity. Duly substantiated reasons must be given for such refusal
Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency	This Directive establishes a common framework of measures for the promotion of energy efficiency within the Union in order to ensure the achievement of the Union's 2020 20 % headline target on energy efficiency and to pave the way for further energy efficiency improvements beyond that date. It lays down rules designed to remove barriers in the energy market and overcome market failures that impede efficiency in the supply and use of energy and provides for the establishment of indicative national energy efficiency targets for 2020.
European Parliament resolution of 12 September 2013 on microgeneration — small-scale electricity and heat	Although devoid of legal effect, the EU Parliament Resolutions affirms that microgeneration must be a vital element in future energy generation if the EU is to meet its renewable energy targets in the long term; recalls that microgeneration is contributing to the increase in the overall share of renewables in the EU energy mix and enables efficient electricity consumption close to the point of generation while avoiding transmission losses and Stresses that microgeneration technologies such as micro-CHP and small-scale renewables make it possible to have zero-energy and positive-energy buildings which feed into the grid surplus electricity generated on the premises; It calls on

generation **(2012/2930(RSP)**	the Commission and the Member States to take steps to publicize microgeneration solutions and best practices in this field and to draw up recommendations, based on best practices for regulators and system operators, on how to shorten and simplify the administrative procedures involved in operating and connecting microgeneration units to the grid, with a particular focus on setting up one-stop-shop procedures;

9.3.1 Standard about hydrogen in buildings

The installation of a system that use hydrogen require safety. The most important standard to design and install a hydrogen system in a building is **ISO/TR 15916:2015**, a technical report focused on safety of hydrogen systems.

The focus of this Technical Report is on the relatively new hydrogen energy applications. The intention is to provide, those unfamiliar with the technology, a basis upon which to understand the safety issues.

Nowadays, hydrogen is an efficient energy carrier and a fuel with minimal environmental impact. System are being developed that produce hydrogen using a variety of energy sources and feedstocks such as sunlight, wind, biomass, hydropower, and fossil fuels, for use in energy applications for home and office heating, generation of electricity and transportation.

This technical report has been drafted to facilitate the rapid spread of the use of hydrogen. It is a guide for information relating to the safety of hydrogen.

Hydrogen is a very abundant element, it can be produced by electrolysis of water, for applications intended for use in the building sector.

In the **Technical Report ISO 22734** is reported the regulatory system to produce hydrogen by electrolysis of water.

Compared to conventional fuels, hydrogen's low density under ambient conditions and its low boiling point makes it difficult for storage of sufficient quantities to suit typical applications. In a generic hydrogen system, there are primary and auxiliary components relevant for hydrogen safety.

The auxiliary components are a fundamental support for the primary components, they are:

- storage vessels
- fluid delivery lines
- piping
- joints
- seals
- flow controls
- pressure-relief system
- detection components.

The elements listed are illustrated and analysed in detail in the Technical Report.

ISO/TR 15916:2015 deals also with measures for the technical safety of facilities, not their security against attacks from the outside. Keeping the hydrogen system away from people and other systems minimizes the problems related to the risk of fire, explosion and detonation. There is a need for a strict analysis of the layout of the plant, allowing only authorized personnel to approach it. The report indicates the safety procedures and protection devices that the personnel must perform, in order to reduce the dangers associated with the use of a hydrogen plant or system.

For the use of hydrogen in the residential sector, various safety parameters must be considered:

- Use of non-combustible materials;
- No spaces where hydrogen can accumulate;
- Minimize sources of ignition;
- Pressure relief system to mitigate deflagrations by venting technique;
- Adequate ventilation;
- Appropriate use of hydrogen detectors.

There are still many aspects to consider increasing the use of hydrogen systems, but this report optimally summarizes all the precautions and actions to be taken to allow rapid development. The considerations presented are broad, general and attempt to address most aspects of hydrogen safety; it reports useful data for design of all systems connected to the use of hydrogen.

Are also reported all the key points regarding the safety issue when using hydrogen for example the problem related to the flammability.

It is exposed to the hazards associated with the storage procedure (elevated storage pressure for gas).

Uncontrolled combustion: a source of hydrogen, for example a leak, when surrounded by an oxidizer such as air, can be ignited to produce a flame much in the same fashion as a burner. In contrast to hydrocarbon fuels such as petrol, which generate most of their radiations as visible light and heat, the hydrogen flame radiates less heat and is practically invisible in broad daylight, for this reason the operators must be trained, and an update of the safety system is necessary; a specific standard would be needed to identify the actions in the event that a flame should spread.

When the standards refer to storage, transport and distribution of hydrogen, the hydrogen embrittlement must be considered. Some metallic materials used in vessels or other component can undergo a significant loss of their ductility when exposed to hydrogen.

The hydrogen embrittlement occurs when hydrogen or hydrogen compounds permeate into the lattice structure of the material. At the atomic level, for embrittlement to occur, hydrogen molecules first must dissociate into atoms before they can diffuse into the metallic structure. This is a particular problem with many ferritic steels if they are subjected to mechanical stresses. Material degradation induced by embrittlement can result in catastrophic failure of containment structures.

There is a need for specific standards for the use of materials in contact with hydrogen to avoid dangers to people or things. The technical report **EN ISO 2626:1997** specifies the method for the hydrogen embrittlement of the copper. **There is a need for standards that specify the test to be carried out against the embrittlement also for other materials used in the hydrogen chain**. The ISO 15916 presents some materials that can help overcome this last problem but bringing with it other problem (no metallic materials: rubber or plastic).

Safety considerations: as a light gas of small molecules, hydrogen requires special equipment and procedure to handle it. Hydrogen is so small it can diffuse into some materials, including some types of iron and steel pipes and increase their chance of failure. Hydrogen is no-toxic gas, but its high flame velocity, broad ignition range and low ignition energy make it highly flammable. It has a flame that is not visible to the naked eye, and it is colourless and odourless, making it harder for people to detect fires and leaks. Protocol for safe handling at these sites are already in place, and they also exist for hydrogen, however, they remain complex and unfamiliar compared to those for other energy carriers.

Other important report about the hydrogen quality and monitoring are:

- **ISO 14687** was developed to specify the quality characteristics of hydrogen fuels to ensure uniformity of hydrogen fuel products for various application

- The **Technical Report ISO 26142** defines the standard for detecting a hydrogen loss.

9.3.2 Referenced Standards

Topic	Technical Committee	Publication Date	Standard	Title	Content
SAFETY of Hydrogen Systems	ISO/TC 197 “Hydrogen Technologies”	December 2015	ISO/TR 15916:2015	Basic considerations for the safety of hydrogen systems	This technical report drafted by ISO proves a comprehensive guideline for the use of hydrogen in its gaseous and liquid forms. It identifies the basic safety concerns and risks, and describes the properties of hydrogen that are relevant to safety. It is very useful to take in account all the risks involved in a system that use hydrogen, as required by a harmonized directive in order to demonstrate the fulfilment of the safety requirements
SAFETY and MONITORING	ISO/TC 197 Hydrogen technologies	June 2010	ISO 26142:2010	Hydrogen detection apparatus – Stationary application	This standard defines the performance requirements and test methods of hydrogen detection apparatus that is designed to measure and monitor hydrogen concentrations in stationary applications. The provisions in ISO 26142:2010 cover the hydrogen detection apparatus used to achieve the single and/or multilevel safety operations, such as nitrogen purging or ventilation and/or system shut-off corresponding to the hydrogen concentration. The requirements applicable to the overall safety system, as well as the installation requirements of such apparatus, are excluded. It sets out only the requirements applicable to a product standard for hydrogen detection apparatus, such as precision, response time, stability, measuring range, selectivity and poisoning.

Topic	Technical Committee	Publication Date	Standard	Title	Content
HYDROGEN GENERATORS: Industrial ant commercial applications	ISO/TC 197 Hydrogen technologies	September 2019	ISO 22734-1	Hydrogen generators using water electrolysis process – Part 1: Industrial and commercial applications	This standard defines the construction, safety and performance requirements of integrated, packaged hydrogen gas generation appliances using electrochemical reactions to electrolyse water to produce hydrogen and oxygen gas
HYDROGEN GENERATORS: residential applications	ISO/TC 197 Hydrogen technologies	November 2011	ISO 22734-2:2011	Hydrogen generators using water electrolysis process – Part 2: Residential applications	This standard defines the construction, safety and performance requirements of packaged hydrogen gas generation appliances, herein referred to as hydrogen generators, using electrochemical reactions to electrolyse water to produce hydrogen, it is applicable to hydrogen generators intended for indoor and outdoor residential use in sheltered areas, such as car-ports, garages, utility rooms and similar areas of a residence and includes cord-connected equipment for outdoor and garage use only.
HYDROGEN GENERATOR Fuel quality	ISO/TC 197 Hydrogen technologies	November 2019	ISO/TR 14687	Hydrogen fuel quality — Product specification	This document is a combination of three former standards for the specifications of hydrogen fuel, ISO 14687-1, ISO 14687-2 and ISO 14687-3, incorporating their revisions at the same time. In recent years, PEM (proton exchange membrane) fuel cell technologies have shown a remarkable progress such as lowering of platinum (Pt)-loading, thinned electrolyte membrane, operation with high current density and operation under low humidity. With this progress, it has become necessary to reconsider the tolerances of hydrogen impurities for the PEM fuel cells which were previously specified in ISO 14687-2 and ISO 14687-3.

Topic	Technical Committee	Publication Date	Standard	Title	Content
HYDROGEN GENERATOR Test	ISO/TC 26 Copper and copper alloys	November 1973, reviewed every 5 years	EN ISO 2626:1997	Copper - Hydrogen embrittlement test	This test is applicable to deoxidized and oxygen-free high-conductivity coppers. ISO 2626 specifies principle, test pieces, and procedure. Embrittlement is revealed by close bending or reverse bending, or by microscopic examination.

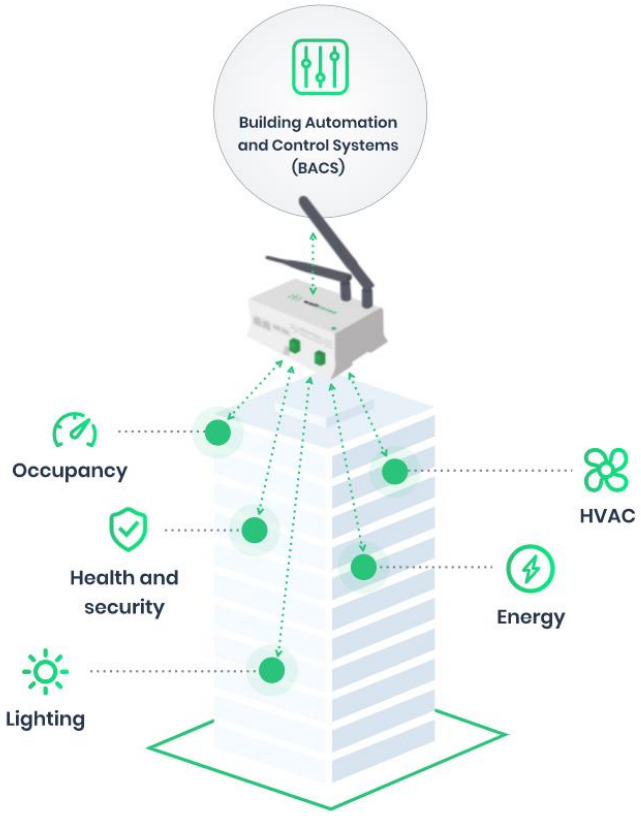
10 Building Management Systems: legislative, standard and policy analysis

10.1 Building Management Systems legislation analysis

The 2018 revision of the European Energy Performance of Buildings Directive (EPBD) aims to further promote smart building technologies. Improving energy performance in buildings is one of the most important projects for the EU to reduce the effects of climate change and Global Warming.

The installation or retrofit of BACS is stipulated through a legislation transposed from the Directive 2010/31/EU of the European Parliament and Council with guidelines from the EPBD.

BACS represents all control and automation solutions, they can optimize overall efficiency and functionality, ensuring that the systems and services are not working against each other.



Smart functions such as demand response, consumption prediction, energy storage, equipment maintenance are all strongly connected to an optimal functioning building. BACS can integrate and optimize these functions too, making buildings “smart” and allowing building managers to have real-time access to cloud-based analytics, reporting and services.

BACS should provide:

- Monitor register and analyse the energy consumption from the building's management system continuously. This data is classified by the functional area and registered at an hourly time step. Monthly data from the building's control system should be archived and available for five years.
- Identify how energy efficient is the building by comparison to the data reference values from established energy studies. The BACS detects efficiency problems in the building, notifies the facility manager, and provides data to help create a strategy to improve energy performance.
- Interoperable with different building management or automation systems.
- The BACS allows manual shutdown and autonomous management of one or multiple building automation systems.

Unfortunately, only 1% of buildings are currently renovated each year, a higher rate is needed to be compliant with the regulatory decree to considerably improve their energy efficiency and reduce their environmental impact. Moreover, buildings included in the regulatory BACS decree are buildings that take part in commercial or non-commercial tertiary activities equipped with a heating or air conditioning system, whose nominal power exceeds 290 kW.

The European Commission should therefore extend the existing requirements, to include medium-size non-residential buildings and larger residential buildings.

Furthermore, the establishment of a **Smart Readiness Indicator (SRI)** for buildings (2018-EPBD) (RD-34) promotes smart building technologies.

"This indicator will allow for rating the smart readiness of buildings, i.e. the capability of buildings (or building units) to adapt their operation to the needs of the occupant, also optimizing energy efficiency and overall performance, and to adapt their operation in reaction to signals from the grid (energy flexibility). The smart readiness indicator should raise awareness amongst building owners and occupants of the value behind building automation and electronic monitoring of technical building systems and should give confidence to occupants about the actual savings of those new enhanced functionalities."

This indicator could become in the future the tool to implement the certification of the state of a building in terms of "digital readiness", favouring the adoption of smart technologies for energy efficiency. **It can be the rewarding driver in national and European financing processes, because it is an internationally recognized indicator for digital and green real estate renovation.**

Nowadays, the SRI is a voluntary provision in the EPBD. Therefore, the next key step will depend on the legal texts defining the SRI definition and methodology and the implementation pathways favoured by the EU Member States

10.1.1 Smart Readiness Indicator

A first technical study to support the establishment of the SRI was launched in March 2017 and conducted by a consortium consisting of VITO NV, Waide Strategic Efficiency, Ecofys and

Offis. A second technical support study - conducted by a consortium consisting of VITO NV and Waide Strategic Efficiency Europe - started in December 2018 and concluded in June 2020 (RD-34).

The main conclusions discussed in the full report of the second technical support study, which also integrates the outcomes of the first technical support study, concern a consolidated proposal for the SRI calculation method and its main components and a proposal of weighting factors for the multi-criteria analysis on impact level.

The assessment time is strongly linked to the degree of complexity of the SRI definition. At least two different SRI assessment types could be envisioned: a light version with a limited set of services and a detailed version. Differentiating between a light version and a detailed version would allow the costs to be brought down for simple buildings, which in turn could increase the uptake. At the same time, the detailed version would permit validation of the added value of advanced systems in complex buildings. On the downside, differentiation may bring confusion, which could hamper the communication of the SRI.
From consideration of these aspects, the study team has investigated the potential SRI assessment methods depicted below.

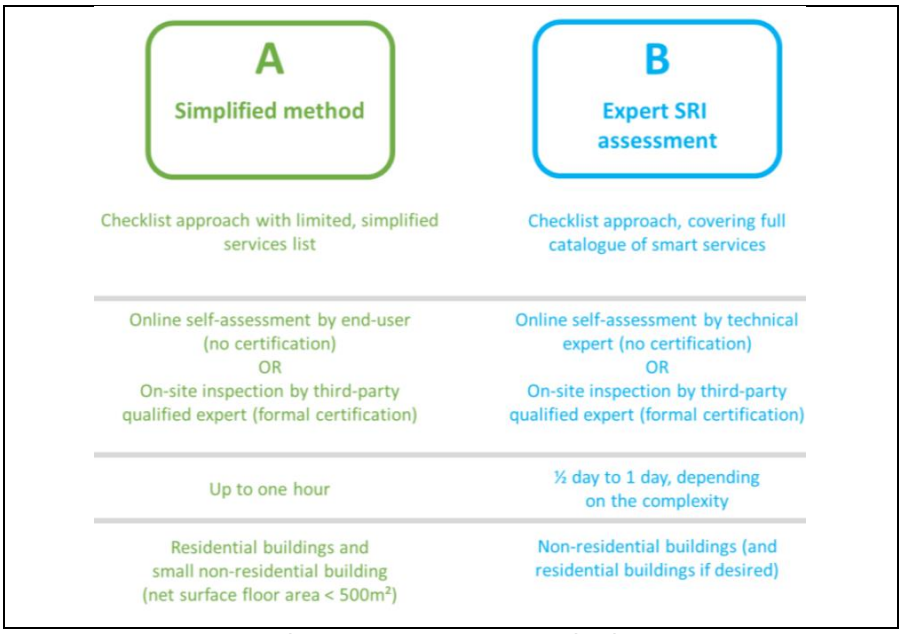


Figure 7 Assessment methods

Method A, the simplified method, is mainly oriented towards small buildings with low complexity (single family homes, etc.). The checklist method could be made accessible for non-experts, such as individual homeowners. Method B, the detailed method, is oriented towards buildings with a higher complexity (typically large non-residential buildings, potentially large multi-family homes).

In accordance with the requirements from the revised EPBD (RD-03), three key functionalities of smart readiness in buildings have been taken into account when defining the smart ready services in the SRI catalogue:
1. The ability to adapt its operation mode in **response to the needs of the occupant**, paying due attention to the availability of user-friendliness, maintaining healthy indoor climate conditions and ability to report on energy use.

2. The ability to **maintain energy efficiency performance and operation** of the building through the adaptation of energy consumption.

3. The **flexibility of a building's overall electricity demand**, including its ability to enable participation in active and passive as well as implicit and explicit demand-response, in relation to the grid.

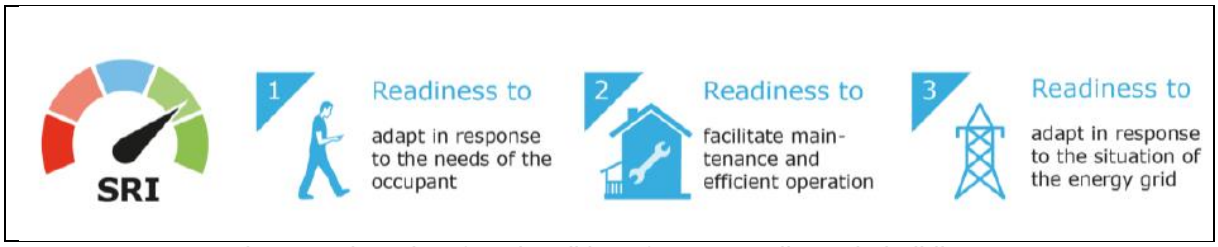


Figure 8 Three key functionalities of smart readiness in buildings

The proposed SRI methodology builds on the assessment of the **smart ready services** present in a building.

In the SRI service catalogues developed, services are structured within nine **domains**: heating, cooling, domestic hot water, controlled ventilation, lighting, dynamic building envelope, electricity, electric vehicle charging and monitoring and control.

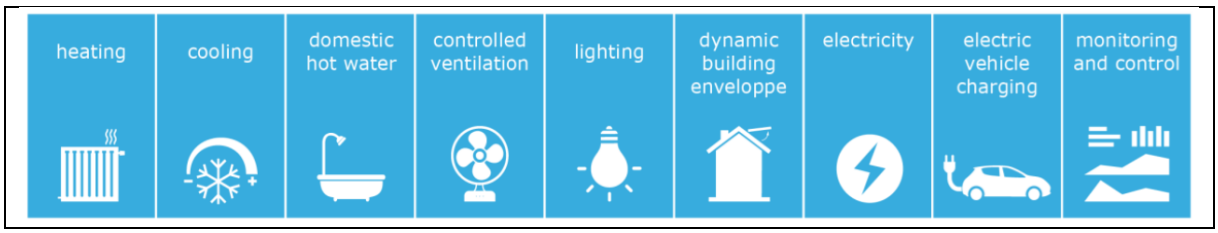


Figure 9 Domains structuring the SRI catalogue

For each of the services, 2 to 5 **functionality levels** are defined. A higher functionality level reflects a “smarter” implementation of the service, which generally provides more beneficial impacts to building users or to the grid compared to services implemented at a lower functionality level.

A smart ready service can provide several impacts to the building, its users and the energy grid. In the proposed approach, a set of seven impact criteria is evaluated, but scores can potentially be aggregated along the three key functionalities mentioned in the EPBD (RD-03). The impact criteria are depicted below.

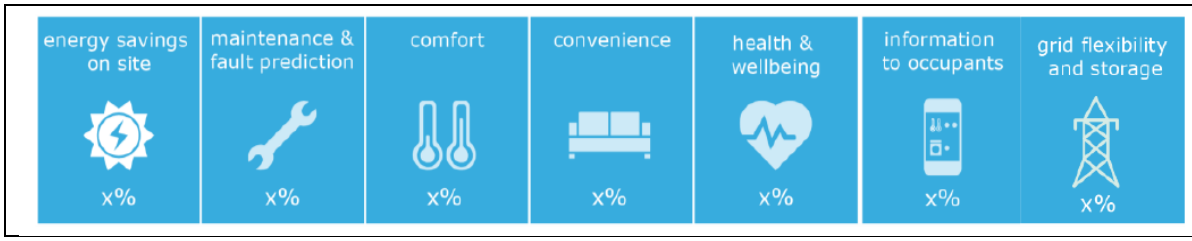


Figure 10 Smart service impact criteria

For each of the smart ready services in the catalogue, provisional impact scores have been defined for their respective functionality levels according to a seven-level ordinal scale. While most of the impacts are positive, the scale also provides the opportunity to ascribe negative impacts.

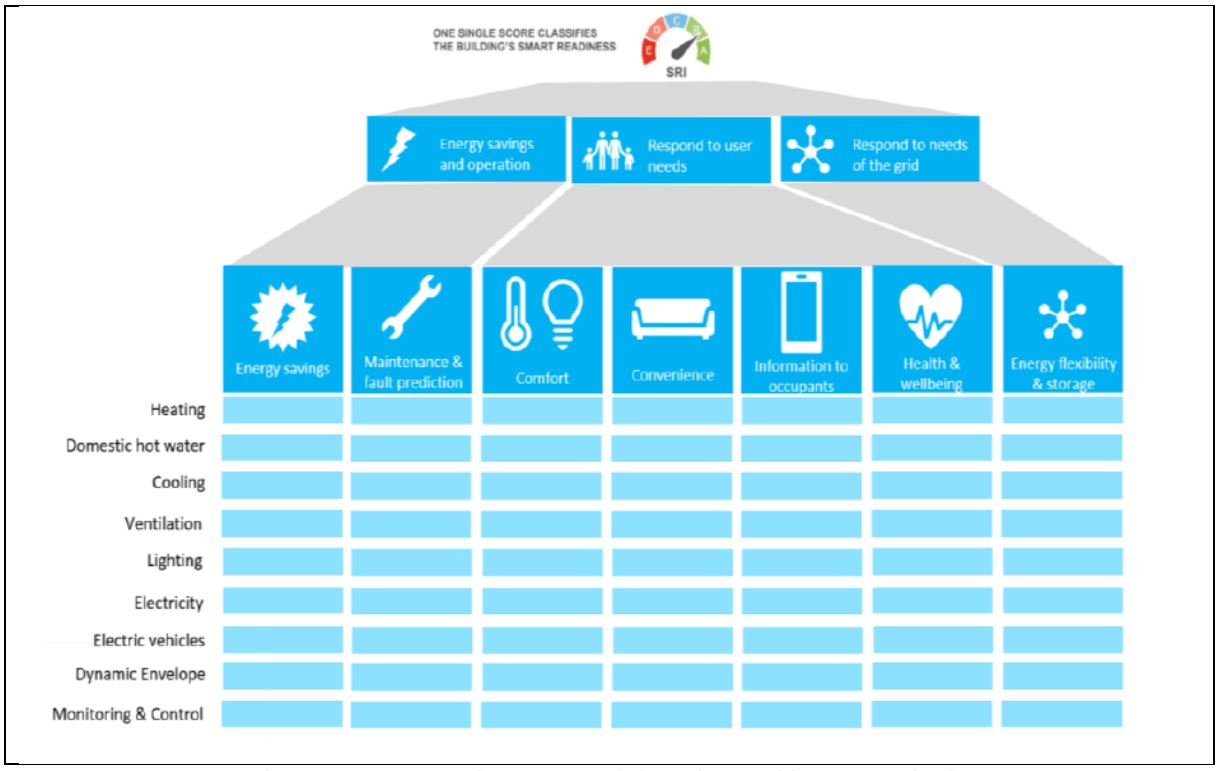


Figure 11 Proposed structure of domains and impacts criteria

The smart readiness score of a building is a **percentage** that expresses how close the building is to maximal smart readiness. The higher the percentage is, the smarter the building. The percentage can also be converted to another indicator, e.g. star rating or alphabetical score (A, B, C, etc.).

The smart readiness score of a building or building unit is expressed as the ratio between the smart readiness of the building compared to the maximum smart readiness that it could reach.

The SRI calculation methodology was successfully tested in a public beta test comprising 112 cases across Europe, which proved the viability of the approach. The proposed SRI calculation

methodology is flexible to allow for adaptations to specific local contexts and allows for future updates in order to keep pace with new innovations in smart products and technologies available on the market, as the integration of a hybrid system.

Finally, the study quantified the costs and benefits of implementing an SRI in the EU building sector for the horizons of 2030, 2040, 2050. The impact analysis reveals that rolling out the SRI across the EU would be strongly beneficial, with the greatest net benefits arising from linking the SRI assessments to the Energy Performance Certification (EPC) assessments of buildings, or the article 8 requirements under the EPBD (RD-03). The SRI could lead to 5% higher final energy savings by 2050, unlocking an increase in investment of 181 billion euro over 30 years compared to a business-as-usual case and up to 32 million tons of avoided greenhouse gas emissions per year.

10.2 Building Management Systems standard analysis

The main standards about the Building Management Systems are four:

- EN ISO 16484 – Design and requirement for BACS
- EN 15232 – Energy efficiency supplied by BACS and TBM
- EN 16946 – Inspection in BACS
- IEC 60364-8 - Low-voltage electrical installations - Energy efficiency

10.2.1 EN ISO 16484 Series

The **EN ISO 16484** includes of 5 documents. It specifies the phases required for building automation and control systems (BACS) projects and requirements for the hardware to perform the tasks within a BACS. It also specifies the requirements for the overall functionality and engineering services to achieve building automation and control systems. Besides, defines data communication services and protocols for computer equipment used for monitoring and control of heating, ventilation, air-conditioning and refrigeration (HVAC&R) and other building systems and the method for verifying that an implementation of the BACnet protocol provides each capability claimed in its Protocol Implementation Conformance Statement (PICS) in conformance with the BACnet standard. This standard contains several Communication Profile Families (CPF), which specify one or more communication profiles.

ISO 16484-1:2010 specifies guiding principles for project design and implementation and for the integration of other systems into the building automation and control systems (BACS).

ISO 16484-2:2004 specifies the requirements for the hardware to perform the tasks within a building automation and control system (BACS). It provides the terms, definitions, and abbreviations for the understanding of ISO 16484-2 and ISO 16484-3. ISO 16484-2:2004 relates only to physical items/devices, i.e., devices for management functions, operator stations and other human system interface devices; controllers, automation stations and application specific controllers; field devices and their interfaces; cabling and interconnection of devices; engineering and commissioning tools.

ISO 16484-3:2005 specifies the requirements for the overall functionality and engineering services to achieve building automation and control systems. It defines terms, which shall be

used for specifications, and it gives guidelines for the functional documentation of project/application specific systems. It provides a sample template for documentation of plant/application specific functions, called BACS points list.

ISO 16484-5:2007 defines data communication services and protocols for computer equipment used for monitoring and control of heating, ventilation, air-conditioning and refrigeration (HVAC&R) and other building systems. It defines, in addition, an abstract, object-oriented representation of information communicated between such equipment, thereby facilitating the application and use of digital control technology in buildings.

ISO 16484-6:2009 defines a standard method for verifying that an implementation of the BACnet protocol provides each capability claimed in its Protocol Implementation Conformance Statement (PICS) in conformance with the BACnet standard.

10.2.2 EN 15232 series

EN 15232 standard is integrated in ISO 52000 series about the energy performance of building.

The EN15232 standard includes:

- A list of control, automation, and technical management functions that affect the energy performance of buildings
- A method for defining the minimum requirements for the control, automation, and technical building management functions implemented in different types of buildings
- Detailed procedures for quantifying the impact these functions have on the energy performance of a building
- Simplified method to obtain an initial estimate of the impact these functions have on the energy performance of buildings

The methods and procedures described within EN 15232 are based on a system of energy classifications assigned to the various BACS and Technical Building Management (TBM) functions.

The standard covers different automation functions, in particular:

- temperature control
- indoor air quality control
- lighting
- drivers and motors
- monitoring, technical alarms and power management
- diagnostic information
- central operation and settings
- remote controls

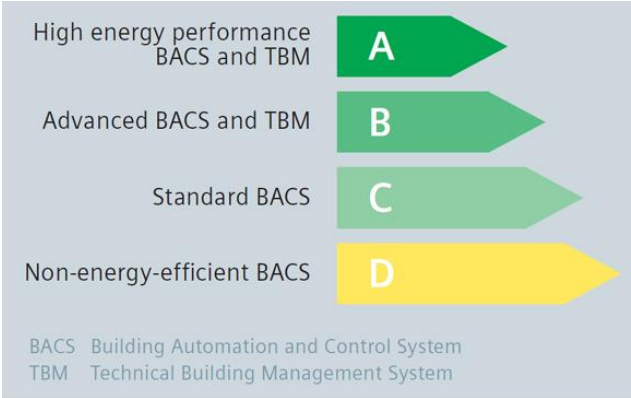
The planning of a BACS implementation or upgrade begins with a building energy audit, which can be performed on three levels, depending on the complexity of the building and systems:

- Preliminary Analysis/Walkthrough

- Energy Survey and Detailed Analysis
- Detailed Analysis for Capital-Intensive Modifications

Additional information concerning energy audit are covered by the series of standards EN 16247 while the upcoming series of standards EN 16946 will focus on “Inspection of Building Automation, Controls and Technical Building Management”.

The EN 15232 standard presents two different procedures for determining the impact of BACS functions on the energy efficiency of a building, one through an estimation based on available coefficients and another one more detailed which require more comprehensive information on the building and proposed systems.



There are also two commonly used financial tools for assessing capital investments such as the installation of BACS. The Payback Method is a relatively simple calculation while a more detailed Life Cycle Analysis allow bettering assess the benefits long after their costs have been recouped.

10.2.3 EN 16946

EN 16946 defines guidelines for the inspection of installed an operational Functions of Building Automation, Controls and Technical Building Management System including its configuration.

10.2.4 IEC 60364-8 series

The standard IEC 60364-8 consists of 3 documents. It provides requirements, measures and recommendations for the design, erection and verification of all types of low-voltage electrical installation including local production and storage of energy for optimizing the overall efficient use of electricity for the electrical part of the energy management system addressed by ISO 50001.

- Part 8-1: Functional aspects - Energy efficiency
- Part 8-2: Prosumer's low-voltage electrical installations
- Part 8-3: Functional aspects - Operation of prosumer’s electrical installations

10.2.5 Referenced Standards

Topic	Technical Committee	Publication Date	Standard	Title	Content
DESIGN ENERGY PERFORMANCE	CEN/TC 247/WG 6 - Electronic control equipment for HVAC applications, integrated room automation, controls and management systems	12/07/2017	EN 15232-1	Energy Performance of Buildings. Impact of Building Automation, Controls and Building Management. Modules M10-4,5,6,7,8,9,10	This European Standard specifies: - a structured list of control, building automation and technical building management functions which contribute to the energy performance of buildings; functions have been categorized and structured according to building disciplines and so-called Building automation and control (BAC); - a method to define minimum requirements or any specification regarding the control, building automation and technical building management functions contributing to energy efficiency of a building to be implemented in a building of different complexities; - a factor based method to get a first estimation of the effect of these functions on typical buildings types and use profiles; - detailed methods to assess the effect of these functions on a given building. This standard is integrated within the set of new EPB standards (EN ISO 52000-1).
DESIGN ENERGY PERFORMANCE	CEN/TC 247/WG 6	28/09/2016	EN/TR 15232-2	Energy performance of buildings - Part 2: Accompanying TR prEN 15232-1:2015 - Modules M10-4,5,6,7,8,9,10	This Technical Report refers to prEN 15232-1, Energy performance of buildings - Part 1: Impact of Building Automation, Controls and Building Management - Modules M10-4,5,6,7,8,9,10. It contains information to support the correct understanding, use and national adaption of standard prEN 15232-1:2015. This technical report does not contain any normative provision.

Topic	Technical Committee	Publication Date	Standard	Title	Content
COMMISSIONING INSPECTION CONFIGURATION	CEN/TC 247/WG 6	03-07-2017	EN 16946-1	Energy Performance of Buildings. Inspection of Automation, Controls and Technical Building Management. Module M10-11	This European Standard defines guidelines for the inspection of installed an operational Functions of Building Automation, Controls and Technical Building Management System including its configuration.
DESIGN INSTALLATION System	ISO/TC 205 Building environment design	11-2010	EN ISO 16484-1	Building automation and control systems (BACS) — Part 1: Project specification and implementation	ISO 16484-1:2010 specifies guiding principles for project design and implementation and for the integration of other systems into the building automation and control systems (BACS). ISO 16484-1:2010 specifies the phases required for the BACS project, including: - design (determination of project requirements and production of design documents including technical specifications), - engineering (detailed function and hardware design), - installation (installing and commissioning of the BACS) - completion (handover, acceptance and project finalization). Also specifies the requirements for as-built documentation and training. It is not applicable to operation and maintenance, nor is it applicable to retro or continuous commissioning, including a commissioning authority.

Topic	Technical Committee	Publication Date	Standard	Title	Content
PRODUCTION Hardware	ISO/TC 205 Building environment design	08-2004	EN ISO 16484-2	Building automation and control systems (BACS) — Part 2: Hardware	ISO 16484-2:2004 specifies the requirements for the hardware to perform the tasks within a building automation and control system (BACS). It provides the terms, definitions and abbreviations for the understanding of ISO 16484-2 and ISO 16484-3. ISO 16484-2:2004 relates only to physical items/devices, i.e. devices for management functions, operator stations and other human system interface devices; controllers, automation stations and application specific controllers; field devices and their interfaces; cabling and interconnection of devices; engineering and commissioning tools. ISO 16484-2:2004 shows a generic system model to which all different types of BACS and their interconnections (BACS network) can fit. A graphical concept of the BACS network in terms of LAN topology will be provided in ISO 16484-5.

Topic	Technical Committee	Publication Date	Standard	Title	Content
DESIGN Specifications	ISO/TC 205 Building environment design	01-2005	EN ISO 16484-3	Building automation and control systems (BACS) — Part 3: Functions	ISO 16484-3:2005specifies the requirements for the overall functionality and engineering services to achieve building automation and control systems. It defines terms, which shall be used for specifications, and it gives guidelines for the functional documentation of project/application specific systems. It provides a sample template for documentation of plant/application specific functions, called BACS points list. The informative function block examples explain a method to display the referenced functions in system documentation; they do not standardize the method for programming functions and applications. This standard covers requirements and definitions regarding BACS and application software, generic functions for plant/project specific applications and engineering functions for building controls and operations. It provides communication functions for the integration of other dedicated special system processes. It defines a method for specifying the procurement specifications containing all essential elements required for the operational functioning of a BACS. The successful installation and operation of a BACS requires that its procurement be based on a complete and accurate functional specification.
PRODUCTION Data Communication Protocol	ISO/TC 205 Building environment design	05-2017	EN ISO 16484-5	Building automation and control systems (BACS) — Part 5: Data communication protocol	The purpose of ISO 16484-5:2017 is to define data communication services and protocols for computer equipment used for monitoring and control of HVAC&R and other building systems and to define, in addition, an abstract, object-oriented representation of information communicated between such equipment, thereby facilitating the application and use of digital control technology in buildings.

Topic	Technical Committee	Publication Date	Standard	Title	Content
INSTALLATION Commissioning	ISO/TC 205 Building environment design	04-2020	EN ISO 16484-6	Building automation and control systems (BACS) — Part 6: Data communication conformance testing	This standard provides a comprehensive set of procedures for verifying the correct implementation of each capability claimed on a BACnet PICS including: (a) support of each claimed BACnet service, either as an initiator, executor, or both, (b) support of each claimed BACnet object-type, including both required properties and each claimed optional property, (c) support of the BACnet network layer protocol, (d) support of each claimed data link option, and (e) support of all claimed special functionality.
DESIGN INSTALLATION	TC 64 - Electrical installations and protection against electric shock	06-02-2019	IEC 60364-8-1	Low-voltage electrical installations - Part 8-1: Functional aspects - Energy efficiency	IEC 60364-8-1:2019(E) provides additional requirements, measures and recommendations for the design, erection and verification of all types of low-voltage electrical installation including local production and storage of energy for optimizing the overall efficient use of electricity. It introduces requirements and recommendations for the design of an electrical installation within the framework of an energy efficiency management approach in order to get the best permanent functionally equivalent service for the lowest electrical energy consumption and the most acceptable energy availability and economic balance. These requirements and recommendations apply, within the scope of the IEC 60364 series, for new installations and modification of existing installations. This standard is applicable to the electrical installation of a building or system and does not apply to products. The energy efficiency of these products and their operational requirements are covered by the relevant product standards. This standard does not specifically address building automation systems.

Topic	Technical Committee	Publication Date	Standard	Title	Content
DESIGN INSTALLATION	TC 64 - Electrical installations and protection against electric shock	10-10-2018	IEC 60364-8-2	Low-voltage electrical installations - Part 8-2: Prosumer's low-voltage electrical installations	IEC 60364-8-2:2018 provides additional requirements, measures and recommendations for design, erection and verification of all types of low-voltage electrical installation according to IEC 60364-1:2005, including local production and/or storage of energy in order to ensure compatibility with the existing and future ways to deliver electrical energy to current-using equipment or to the public network by means of local sources. Such electrical installations are designated as prosumer's electrical installations (PEIs). This document also provides requirements for proper behaviour and actions of PEIs in order to efficiently obtain sustainable and safe operations of these installations when integrated into smart grids. These requirements and recommendations apply, within the scope of IEC 60364 (all parts), for new installations and modification of existing installations

Topic	Technical Committee	Publication Date	Standard	Title	Content
DESIGN INSTALLATION	TC 64 - Electrical installations and protection against electric shock	27-05-2020	IEC 60364-8-3	Low-voltage electrical installations - Part 8-3 : Functional aspects - Operation of prosumer's electrical installations	IEC TS 60364-8-3:2020 (E) specifies requirements and recommendations for the safe and proper functioning of prosumers' electrical installations. It is intended for use by contractors, users, facility managers and similar of electrical low-voltage installations. This document also provides requirements and recommendations on technical parameters and their limiting values influencing: a) safety: protection; alarm; b) proper functioning: – stability (voltage, frequency, etc); – reliability (power quality, interoperability of communication, etc); – energy management (power, power factor, current, stored energy, etc); – ability to ensure correct operation of equipment. This document also provides requirements and recommendations on data exchange models, and test procedures for the prosumer's electrical installations that could include the following applications: – local generating sources (e.g. photovoltaic systems, rotating generators, wind turbines); – energy storage units (e.g. stationary secondary batteries); – electric vehicle charging and/or discharging; – prosumer's energy measurement unit (PEMU); – control and monitoring system; – loads which can be controlled.

11 Conclusions

SCORES project includes several innovative technologies for the development of hybrid thermal and electric plants, that will allow to have energy self-sufficient homes during next few years.

The most innovative technologies involved, like second life batteries, hydrogen based thermal storage, Building Management System, can receive incentive from MS energy efficiency programmes, otherwise legislative barriers already exist. The application of these technology in tertiary and residential sectors require an update of legislation.

In this deliverable the main legislation and standard has been described and the main issues already open have been raised.