White Paper

Task force 3: Building interactions with the external environment

Topic B:

Smart building as enabler of new energy practices and communities

Revision: V2

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Disclaimer

Executive summary

The SmartBuilt4EU project has set up four task forces investigating issues related to smart buildings: their objective is to identify the remaining challenges and barriers to smart building deployment, and the associated research and innovation gaps that should be addressed in the near future.

Task force 3 investigates how smart buildings can interact at best with their external environment. A first white paper discussed the grid-interacted, consumer-engaging building and is available via https://smartbuilt4eu.eu/publications/ . The topic currently addressed by this task force and presented in this paper is: " smart buildings as enabler of new energy practices and communities."

This white paper therefore aims to provide an overview on what is known and what should be further investigated to answer the following questions:

- Buildings and energy efficiency: how can the building facilitate or foster the development of new energy practices in electricity and heat?
- Buildings and energy communities: beyond the single building scale, which smartness requirements act as enablers of energy communities?

In its first part, after a reminder of terminology on active consumers and prosumers, this paper provides a state of the art regarding the contribution of Electricity Directives to new customer-centric energy practices and new communities as well as the contribution of EPBD to the definitions; The literature review focuses on energy communities as novel entrants in the energy value chain, on the 'smart built environment readiness' framework with regard to new energy efficiency practices and electromobility. Finally, interaction between electromobility and buildings is presented around the perspective of the new 'Right to plug' requirement as a trigger for home charging roll-out.
Specific attention was paid to a selection of EC-funded projects REACT, SPHERE, BIM4RE, PHOENIX, MERLON while a set of other related initiatives are listed.

A brainstorming process during an ad hoc workshop enabled to identify some key barriers and drivers regarding optimised building costs. The next diagrams provide an overview of the main barriers and drivers discussed.

Figure 1: Overview of main barriers

VALUE CHAIN	1. Interoperability vendor lock-in and harmonisation in EU
	2. No standard access to building infrastructure, impacts 'industrialisation of smart services'
REGULATION	3. Lack of incentives or at least lack of awareness of existing schemes in a given country
	4. Uncertainty about evolving regulation, tariff, energy landscape, lack of tailor-made policies
	5. For EV lack of national regulations in most EU countries imposing charging infrastructure in multi-apartment building
SOCIAL	6. Lack of perceived added value by prosumers, who need more integrated offers
	7. Lack of awareness/knowledge on technos & smart services functionalities by consumers
	8. Lack of trust about energy communities with fear of loss of privacy or self-decision ability
ECONOMIC	9. Complexity of business models (EE services, Energy communities), impacting the understanding of financial added value
	10. High investment cost of smart solutions and related IT infrastructure with regards to the longer-term economic gain from energy savings
TECHNICAL	11. Legacy installations not ready for EV smart charging, lack of electrical inspection regimes
	12. Lack of maturity and limited return on experience on EV charging technologies
	13. Lack of intuitive controls and/or good and simple manuals for EE management

Top barriers according to the Task Force (barriers 1, 6, 9 and 11)

Figure 2: Overview of main drivers

VALUE CHAIN	1. Energy production becoming more intermittent, distributed and diverse (PV, CHP,...)
	2. Affordability of PV which will lead to new prosumers
	3. Solid trend on electromobility will push building industry to fit to this demand by adapting the construction
REGULATION	4. Modernisation in EPBD: including smartness requirements, Right to Plug (legal basis for EV owners to be able to install a charger), etc
SOCIAL	5. Positive social pressure on energy scarcity and its management with increasing awareness
	6. Flexibility in energy uses (consumption and self-supply) perceived as an insurance policy in the fast-evolving energy landscape
	7. Increasing demand on tool for energy management by end users (similar to e-banking)
	8. Energy-vulnerable consumers constitute a mass market with high impact potential
ECONOMIC	9. Evolution of pricing in function of capacity instead of consumption
	10. Market potential of consumer-related data
TECHNICAL	11. Broad(er) availability of digital meters with IoT everywhere at zero costs
	12. Certified installers able to ensure quality of installed systems

Top drivers according to the Task Force (drivers 1, 4, 9 and 12)

Based on the State of the Art and the barriers and drivers, a number of research and innovation gaps were identified. They are synthetised in the next diagrams.

Figure 3: Research & Development gaps

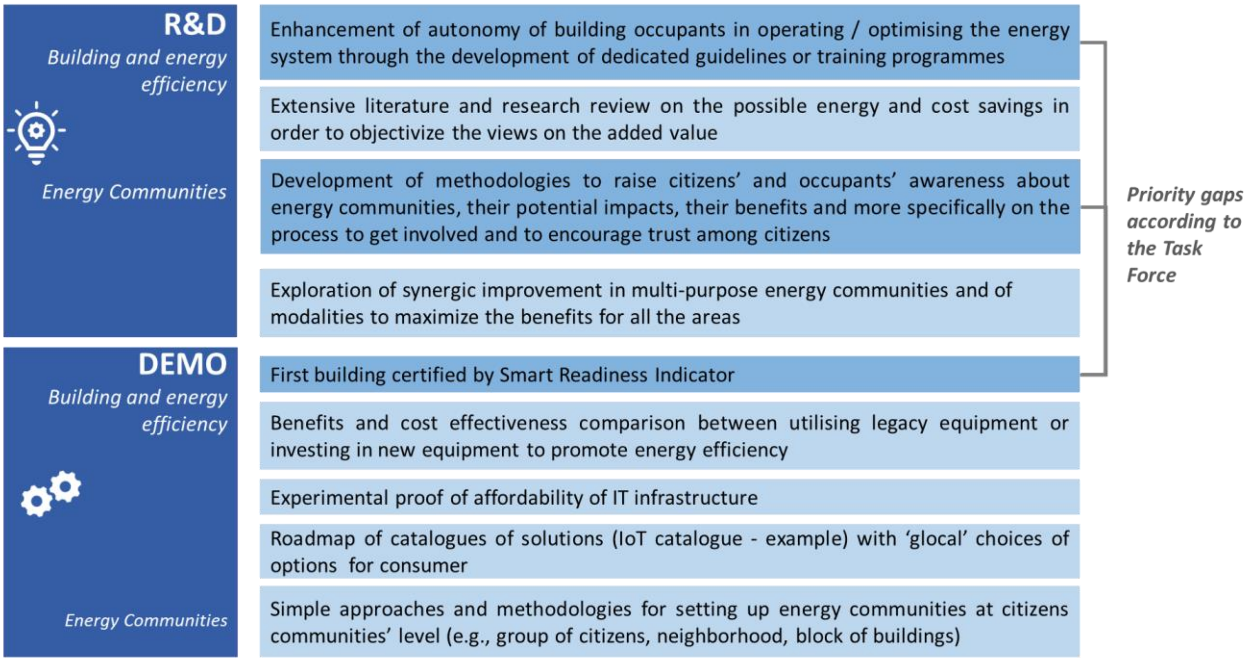
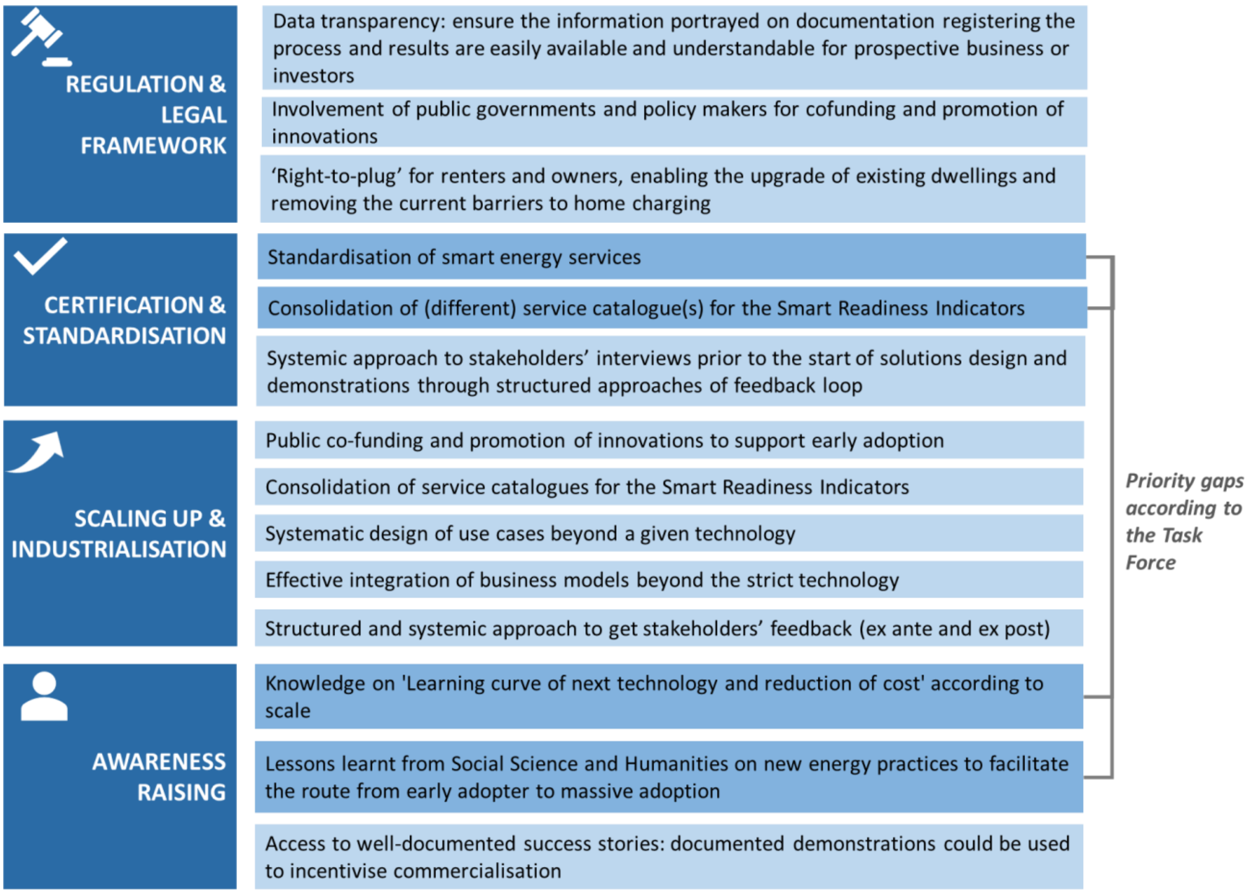


Figure 4: "Go-to-market' gaps



The gaps identified above will feed the elaboration of the Strategic Research and Innovation Agenda on smart buildings that will be produced by the SmartBuilt4EU consortium by mid-2023, together with some recommendations targeting policy makers.

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List of abbreviations

A&P	Adapt-&-Play
AIOTI	Alliance for the Internet of Things Innovation
API	Application Programming Interface
BAC	Building Automation and Control
BEMS	Building Energy Management Systems
BIM	Building Information Modelling
BMS	Building Management Systems
CEP	Clean Energy for all Europeans Package
DR	Demand Response
DSO	Distribution System Operator
DT	Digital Twins
EC	European Commission
EEB	Energy Efficient Building
EMDII	Electricity Market Directive (recast), 2019/944
EMS	Energy Management Systems
EPBD	Directive amending the Energy Performance of Buildings Directive (2018/844/EU)
EPBDp	Proposal for a Directive on the energy performance of buildings (recast), 15 Dec 2021
EV	Electric Vehicles
GDPR	General Data Protection Regulation
GHG	Greenhouse gasses
GIS	Geographic Information Systems
HVAC	Heating Ventilation and Air Conditioning
ICT	Information and Communication Technologies
IFC	Industry Foundation Classes
IoT	Internet of Things
nZEB	Nearly Zero Energy Building
REDII	Renewable Energy Directive (recast), 2018/2001
RES	Renewable Energy Systems
R2S	Ready2Service
SAREF	Smart Appliances REFerence
SRI	Smart Readiness Indicator
TBS	Technical Building System
TF	Task Force

1. Introduction

This white paper is produced in the context of the SmartBuilt4EU project, a coordination and support action funded by the European Commission to bring together the research and innovation community on smart buildings.

The SmartBuilt4EU project has set up four task forces with volunteers all across Europe, investigating topics related to smart buildings. They respectively address the interaction between building and end-user, efficient building operation, interactions between the building and the external environment, and cross cutting issues.

Figure 5: The four task forces set up by the SmartBuilt4EU project

SmartBuilt4EU task force 3 investigates how the smart building can interact with its external environment in a mutually beneficial way. The first line of investigation focused on the Smart buildings as providers of flexibility to the electricity grids[1].

The present White Paper focuses on the second topic, namely "smart buildings as enablers of new energy practices and communities". It presents the outcomes of a collective work, carried out with the members of the task force, in several steps:

- Agreement on the scope
- Review of the state of the art and identification of the points to be specifically investigated
- Analysis of barriers and drivers
- Identification of R&I gaps
- Key conclusions on the topics and recommendations.

2. Topic under investigation by the task force

2.1. Rationale

Smart building is expected to play a key role in the energy transition, but this role needs to be clearly defined and characterised, on a technical level as much as on a business level. Current R&I already addresses how smart buildings interact with various network, acting as a node of sector coupling among them.

After Topic A focused on the interface between the smart building in its interaction with the power system, Topic B focuses here on the interaction of the smart building with other types of infrastructures. The wide range of options led us to concentrate on three types of such networked infrastructures and activities:

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[1] SB4EU White Paper, task force 3 Topic A: Smart buildings as flexibility providers to the electricity grids. Final version, September 2021

- interaction with electromobility
- interaction with energy communities
- interaction with electricity / heat generation and consumption practices.

These interactions have indeed been considered of prime importance with regards to the 'smartness' impact of a building in its surrounding context.

One could observe that a common feature offers an analysis perspective: starting from the point of view of building, they all refer to the deployment of new energy practices[2] which are enabled by new organization and communities associated to these practices (energy communities, exchanging energy services at very local scale and leveraging cloud services) or by technology increasing in maturity and penetration level (electromobility).

2.2. *Scope*

Initial questions proposed to task force members to initiate the discussion referred to the smartness requirements for buildings to develop such new energy practices, interaction with electromobility and emergence of new organization such as energy communities. All along the discussions, scope was slightly refocused on the smartness requirements for building with respect to two main domains:

- **Buildings and energy efficiency:** how the building could facilitate or foster the development of new energy practices in electricity and heat?
- **Buildings and energy communities:** beyond the single building scale, which smartness requirements are enablers of energy communities?

The collected inputs from participants and analysed projects have been mapped and reorganized according to the two main domains.

task	Illustration of content
Heating solutions and new practices	
▪ Data collection and use	Focus on data framework, digitalization of buildings, interaction with big data and learning
▪ Buildings' infrastructure	Focus on the building, its renovation process in all the stages from design, execution and quality assessment
▪ Scalability of solutions	Focus on adequate ecosystems, smart readiness framework analysis or readiness for replication, modularity of solutions
Buildings and energy communities	
The building itself through its interface(s) and value(s)	
▪ Smart readiness indicator	Building readiness for interoperability and synergies with other systems and sectors, readiness for synergies between on-site energy storage and on-site RES, or interaction of building with other systems / sectors
▪ Enabling technologies	As facilitating interoperability and synergies (e.g., blockchain and IoT for more RES integration or nZEB envelope solutions)

[2] improved energy efficiency, distributed generation of renewable electricity, renewable electricity self-consumption, possibly coupled with energy storage or shared storage models, integrated electro mobility

▪ Business Models for designing and assessing the created value	Value refers to topics related to business model for cost effective building to X solutions
Commitment and momentum, the user perspective	
▪ Early adopters	Critical to secure the go-to-market strategy
▪ User experience	Critical to empower users
Regulation and welfare, the 'society' perspective	
▪ Regulation	Addressing the regulatory context (see EPBD revision) with regard to wider scales
▪ Upscaling to district and city levels	Reaching larger geographic scales beyond the strict building

The scope of the topic investigated by this Task force is thus synthesised as follows:

- A terminology update from related directive REDII, EMDII and EPBD especially on active consumers and energy communities
- The new proposal for amending the EPBD directive: new concepts and revised definitions
- The right to plug concept for renters and owners for electromobility, enabling the upgrade of existing dwellings and removing the current barriers to home charging

The lessons learnt by EC funded projects are also included in section 3.3 following a terminology reminder (section 3.1) and the literature review (section 3.2).

3. State of the Art

Energy citizens, active consumers and prosumers are terms that are often used in parallel, referring to individuals, households, public or private companies that move from a role of being only energy consumers (implicitly passive) to also become active stakeholders of the energy system, generating energy and contributing to the electricity system balance. Such 'prosumtion' role could be done by various means (e.g., provision of flexible demand, PV, energy storage) in response to the growing share of variable renewable energy sources generation.

A set of formal definitions is introduced below in relation to this topic. Note that definitions related to smartness and the smart readiness indicator are mentioned but not detailed, as already discussed in the first white paper of task force 3.

3.1. Definitions

3.1.1. The contribution of Electricity Directives (EMDII and REDII) to new customer-centric energy practices and new communities

EMDII stands here for the Electricity Market Directive (recast)[3], while REDII refers to the revised Renewable Energy Directive[4].

[3] (EU) 2019/944 (European Parliament & Council of the European Union, 2019)

[4] Renewable Energy Directive (EU) 2018/2001 (European Parliament & Council of the European Union, 2018).

The new concepts around energy community as a novel legal form to implement energy consumer-centric practice are defined in these two directives implementing the Clean Energy for all Europeans Package (CEP). Article 2 of REDII and Article 2 of EMDII sets the legal terminology background. A selection of definitions is proposed below.

Article 2 – Definitions from EMDII
2. (1) 'customer' means a wholesale or final customer of electricity;
2.(8) 'active customer' means a final customer, or a group of jointly acting final customers, that consumes or stores electricity generated within its premises located within confined boundaries or, where permitted by a Member State, within other premises, or who sells self-generated electricity or participates in flexibility or energy efficiency schemes, provided that those activities do not constitute its primary commercial or professional activity;
2.(11) 'citizen energy community' means a legal entity that: (a) is based on voluntary and open participation and is effectively controlled by members or shareholders that are natural persons, local authorities (including municipalities), or small enterprises; (b) has for its primary purpose to provide environmental, economic or social community benefits to its members or shareholders or to the local area where it operates rather than to generate financial profits; and (c) may engage in generation, including from renewable sources, distribution, supply, consumption, aggregation, energy storage, energy efficiency services or charging services for electric vehicles or provide other energy services to its members or shareholders;
Article 2 – Definitions from REDII
2.(14) 'renewables self-consumer' means a final customer operating within its premises located within confined boundaries or, where permitted by a Member State, within other premises, who generates renewable electricity for its own consumption, and who may store or sell self-generated renewable electricity, provided that, for a non-household renewables self-consumer, those activities do not constitute its primary commercial or professional activity;
2. (15) 'jointly acting renewables self-consumers' means a group of at least two jointly acting renewables self-consumers in accordance with point (14) who are located in the same building or multi-apartment block;
2.(16) 'renewable energy community' means a legal entity: (a) which, in accordance with the applicable national law, is based on open and voluntary participation, is autonomous, and is effectively controlled by shareholders or members that are located in the proximity of the renewable energy projects that are owned and developed by that legal entity; (b) the shareholders or members of which are natural persons, SMEs or local authorities, including municipalities; (c) the primary purpose of which is to provide environmental, economic or social community benefits for its shareholders or members or for the local areas where it operates, rather than financial profits;

These definitions must be completed with the dedicated articles to the new concepts introduced by the two Directives[5]

- Article 15 of EMDII on Active consumers

[5] Citizen Energy Community (CEC) is described in Directive (EU) 2019/944 (recast Electricity Directive) and Renewable Energy Community (REC) is defined in Directive (EU) 2018/2001 (the recast Renewable Energy Directive)

- Article 16 of EMDII on Citizen energy communities
- Article 21 of REDII on Renewables self-consumers
- Article 22 of REDII on Renewable energy communities

A comparison of common and distinct features is discussed in the next chapter focusing on energy communities.

3.1.2. The contribution of EPBD to the definitions

Regarding the directives on the Energy Performance of Buildings one shall consider:

- The Directive amending the Energy Performance of Buildings Directive (2018/844/EU)
- The Concerted Action that supports the EPBD implementation

The current proposal made on 15 December 2021 'Proposal for a Directive on the energy performance of buildings (recast), COM (2021), 2021/0426 (COD)[6] is detailed in the next section.

Amendments to Directive 2010/31/EU – Modified definitions from Directive 2018/844/EU Article 1
2.(3) "'technical building system" means technical equipment for space heating, space cooling, ventilation, domestic hot water, built-in lighting, building automation and control, on-site electricity generation, or a combination thereof, including those systems using energy from renewable sources, of a building or building unit;
2.(3a) 'building automation and control system' 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;
'15a. 'heating system' means a combination of the components required to provide a form of indoor air treatment, by which the temperature is increased;
15b. 'heat generator' means the part of a heating system that generates useful heat using one or more of the following processes: (a) the combustion of fuels in, for example, a boiler; (b) the Joule effect, taking place in the heating elements of an electric resistance heating system; (c) capturing heat from ambient air, ventilation exhaust air, or a water or ground heat source using a heat pump;
15c. 'energy performance contracting' means energy performance contracting as defined in point (27) of Article 2 of Directive 2012/27/EU of the European Parliament and of the Council[7] ;

Concerted Action EPBD V, support to the implementation of EPBD
This support takes the form of exchange of information and experience among Member States and other participating countries and core teams' activities[8].

[6] https://ec.europa.eu/energy/sites/default/files/proposal-recast-energy-performance-buildings-directive.pdf

[7] Directive 2009/72/EC 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 (OJ L 211, 14.8.2009, p. 55).

[8] https://cordis.europa.eu/project/id/820497/fr

Next to core teams dealing with nZEB, building codes, existing buildings, renovation strategies, certification and training, a dedicated core team (CT6) deals with the concept of smart building. Despite no commonly accepted definition of a Smart Building currently exists, EC supported initiatives such as SRI are working in that direction, supported by the activity of CT6 which produced a status report in 2020[9].

3.1.1. The Proposal for a Directive on the Energy Performance of Buildings (recast), COM (2021)

The revision of the Energy Performance of Buildings Directive (EPBD) is part of the 2021 Commission Work Programme "Fit for 55" package and complements the other components of the package proposed in July 2021 setting the vision for achieving a zero-emission building stock by 2050.

They also result from initiatives from industry and professional associations such as EHPA, EU.BAC, EUROPEON, RESCOOP.EU, SmartEn, SolarPower Europe, rhe coalition for Energy savings, EPEE, European Alliance to Save energy, cecapi, European Copper Institute, EDIEES, EGEC geothermal. See Letter-EPBD-revision.pdf (smarten.eu) dated 28 October 2021.

Below are some excerpts from the proposal highlighted.

- **Revised and new definitions (Article 2).** New definitions of ZEB are introduced and the definition of nZEB is clarified**.**
- **Updated methodology is proposed for** calculating the energy performance of buildings (Article 4)
- **Updated methodology for the calculation of cost-optimal levels** specifying that the costs of GHG allowances as well as environmental and health externalities of energy use are to be considered (Article 6)
- **Provisions on new buildings are detailed in Article 7,** specifying among other that new buildings in 2030 must be zero-emissions as of 2027. The proposal also introduces voluntary renovation passports to equip building owners planning a staged renovation of their building with a time horizon end of 2024 or a common framework to be developed by the Commission.
- **On heating systems, air quality and technical building systems,** the proposal encourages the swift deployment of heating systems with zero direct emissions with the provision that ZEB should not generate carbon emissions on-site. A clear legal basis for national bans of boilers based on fossil fuels is introduced in Article 8. It also requires the installation of measuring and control devices for the monitoring and regulation of indoor air quality in new buildings.
- **Current requirements for infrastructure for sustainable mobility** are reinforced in Article 12, introducing the pre-cabling as a norm for new buildings and ensuring the "right to plug" concept.
- **Pre-cabling** becomes the norm for all new buildings and buildings undergoing major renovation, and the rollout of **recharging points** in new and renovated office buildings is reinforced. Recharging points need to enable smart charging and Member States shall remove barriers to the installation of recharging points in residential buildings, **ensuring a "right to plug"** in line with the relevant provisions in the proposal for an Alternative Fuels Infrastructure Regulation. Articles 16 to 19 focus on the improvement of the already existing provisions on energy performance certificates, their issuing and display, and their databases.
- The introduction of the **Smart Readiness Indicator** (SRI), "*an assessment of the capabilities of a building or building unit to adapt its operation to the needs of the occupant and the grid and to*

[9] https://epbd-ca.eu/wp-content/uploads/2021/12/CT6-Smart-Buildings-2020.pdf in https://epbd-ca.eu/database-of-outputs

improve its energy efficiency and overall performance", as detailed in the first white paper of task force 3.

A brief selection of new definitions of the Article 2 of the proposal are reported in the table below. New elements are in blue colour and ~~removed elements are barred.~~

Proposal for a Directive on the energy performance of buildings (recast) COM (2021): selected definitions
2.3 'technical building system' means technical equipment for space heating, space cooling, ventilation, domestic hot water, built-in lighting, building automation and control, on-site renewable energy ~~electricity~~ generation and storage, or a combination thereof, including those systems using energy from renewable sources, of a building or building unit;
2.18 'renovation passport' means a document that provides a tailored roadmap for the renovation of a specific building in several steps that will significantly improve its energy performance;
2.34 'smart charging' means smart charging as defined in Article 2(14l) of Directive (EU) 2018/2001 [amended RED];
2.35 'bidirectional charging' means bidirectional charging as defined in Article 2(14n) of Directive (EU) 2018/2001 [amended RED];
2.49 'energy from renewable sources produced nearby' means energy from renewable sources produced within a local or district level perimeter of the building assessed, which fulfils all the following conditions: (a) it can only be distributed and used within that local and district level perimeter through a dedicated distribution network; (b) it allows for the calculation of a specific primary energy factor valid only for the energy from renewable sources produced within that local or district level perimeter; and (c) it can be used on-site of the building assessed through a dedicated connection to the energy production source, that dedicated connection requiring specific equipment for the safe supply and metering of energy for self-use of the building assessed;

3.2. Literature review

3.2.1. Energy communities, new entrants in the energy value chain

The **Clean Energy for all Europeans Package** (CEP)[10], adopted in 2019, constitutes a cornerstone of EU's energy policy framework in the transformation to non-carbon economy. It strengthens the role of the consumer with the introduction of a new market actor: the Energy Community, aiming at increasing public acceptance of renewable energy projects, mobilizing private capital and introducing grid flexibility. It confirms the prominent role of prosumers, and the collective role they will play in the future energy system. Introduction of Energy Communities into national regulations by EU member states followed the directives proposing the formal definitions. Strengthening the role of consumer as active link within the electricity system means that the role of building is reinforced. The role of energy consumers as active participants in the energy system is bound to expand. As of now, individual or municipality-based initiatives emerge with the purpose to be self-sufficient and rely on renewables only. Long term impacts of European households (individually or through energy communities) are very significant: **it is expected that, at 2050-time horizon,**

[10] Clean Energy for All Europeans Package is a set of legislative proposals and several non-legislative initiatives, covering a wide domain of energy issues (energy efficiency, renewable energy, electricity market design, governance rules, energy security, e tc.)

almost half of EU households will be producing renewable energy and even more could provide demand flexibility with their electric vehicles, smart e-boilers or stationary batteries with projections up to 83% of the EU's households being potentially energy citizens[11].

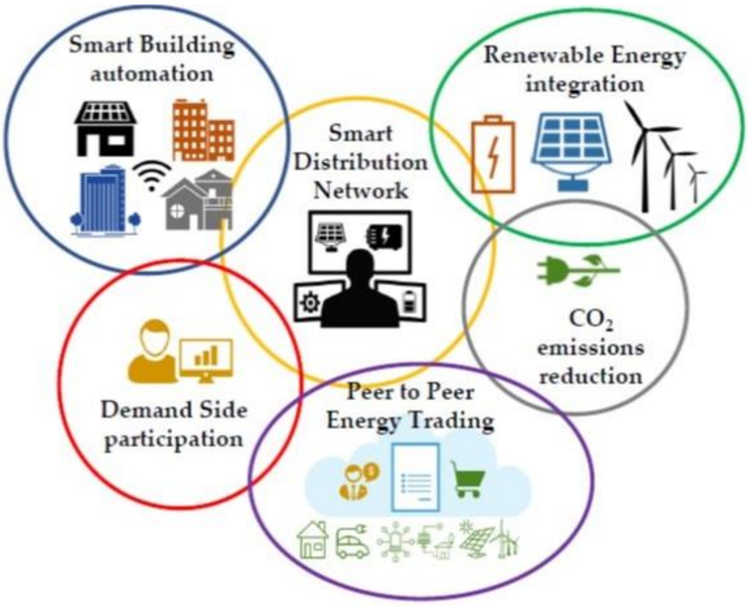

Figure 6: key concepts underlying the energy communities (Source: E. Ghiani et al.)

The **report of JRC** published in 2020 [12] provides an overview of the activities, organisation and implications of energy communities as participants in the energy system. Community energy refers to a wide range of collective energy actions that foster citizens' participation in the energy system.

From the legislative perspective, the CEP introduces two formal definitions of energy communities:

- 'citizen energy communities' (CEC) included in the revised Internal Electricity Market Directive[13], and
- 'renewable energy communities' (REC) included in the revised Renewable Energy Directive[14].

The above directives formally acknowledge and set out legal frameworks for certain categories of community energy as 'energy communities': groups of citizens, social entrepreneurs, public authorities, and community organisations are thus empowered to directly participate in the energy transition by investing in, producing, selling and distributing energy. Both citizen and renewable energy communities aim to provide economic, social or environmental benefits to the community rather than generating financial profits, by offering open and voluntary participation, making sure that participation in an energy community should not constitute the members'/shareholders' primary commercial or professional activity.

At the same time, they may differ on some characteristics as described by the two directives. It should also be noted that the future interaction with DSO is described in the directives in a high-level manner, and it is up to the Member States to add details in their transposition in their national regulations. The table below illustrates some of the main common and distinctive features.

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[11] https://cedelft.eu/publications/the-potential-of-energy-citizens-in-the-european-union/

[12] 'Energy communities: an overview of energy and social innovation' https://publications.jrc.ec.europa.eu/repository/bitstream/JRC119433/energy_communities_report_final.pdf

[13] (EU) 2019/944 (European Parliament & Council of the European Union, 2019)

[14] Renewable Energy Directive (EU) 2018/2001 (European Parliament & Council of the European Union, 2018).

Table 1: Comparison of Energy Communities according to EMDII and REDII

Feature	CEC	REC
Energy type	Electricity from all sources	Electricity and heat from RES
Activities	Wide coverage production, supply, aggregation, energy services, etc.	Constrained (production, consumption, sell, store)
Key market actors	Citizens, local authorities and small and micro enterprises	
Clean Energy Package Directive (CEP) Directive	Electricity Market Directive (Article 16)	Renewable Energy Directive (Article 22)

3.2.2. Electromobility and buildings

A steady trend towards the electrification of mobility end use impacts multiple sectors, often studied from the point of view of the power system.

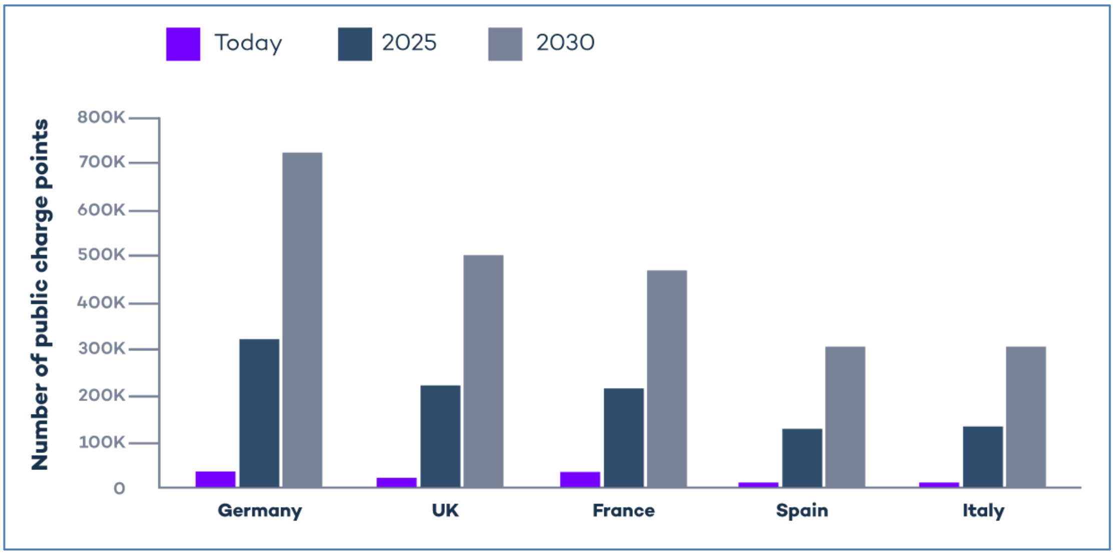


***Figure 7: Road2Zero scenario on number of charging points required by 2030 in selected EU countries. Close to 3 million are estimated by 2030 for the whole EU** (source Transport & Environment, 2020)*

Electrification of mobility end uses, and in particular electric vehicles (EV) will impact energy, automotive and building industries and all relevant authorities.

- 18% of the car fleet is parked overnight in multifamily dwellings
- 99% of m multifamily dwellings are existing buildings (vs new ones)
- Charging an eV to drive a daily distance of 40 km would increase by 80% the daily demand of average EU household consumers

The interface of batteries embedded in EV as source of flexibility for the power system are studied in multiple multidisciplinary projects involving academic, grid and mobility or flexibility operators. Smart charging (V1G) and vehicle-to-grid (V2G) are two feasible technologies to integrate electric vehicles into the power system[15]. Some European projects explore smart charging strategies and their impacts to stakeholders, develop some tools for economic assessment for such vehicle-to-grid services or the EV end user acceptance.

It is also observed that the generic term vehicle-to-grid refers to a wide range of applications in which the electric vehicle's battery is used to buffer electricity. Options include 'vehicle-to-home', 'vehicle-to-office/ building', and the actual 'vehicle-to-grid', each application having its own value proposition. Each of the variants has pros and cons, but vehicle-to-grid proved to be less mature and less implementable to the DSOs (source: H2020 INVADE project). Most of EU-funded projects however focus on the impact to the power system, the interface with the building industry being less explored.

The 'Right to plug' requirement as a trigger for home charging roll-out

More specifically the right to plug could speed up electromobility in buildings and the rollout of home chargers as it would include provisions to avoid e.g. a single neighbour blocking the installation of a plug as analysed by the European Copper Institute[16]. Whereas now, in some EU countries, all homeowners must approve the installation of a charging station in a shared building.

A documented status of 'Right to Plug' regulation in Europe is proposed by the European Copper Institute pointing at regulatory barriers and market failures that may impede the deployment of electromobility infrastructure and recommending integrating this requirement in the proposal for the Directive revision.

Status on the 'Right to plug' regulation in Europe

As 80% to 95% of charging is done at home, buildings are the main enablers of e-mobility but suffer from a lagging policy framework. Current middle-segment full electric passenger cars have a range of around 400 km, more than enough for everyday use. With an EU average daily driven distance by passenger cars of 50 km, a charger of 3.7 kW will replenish the energy used during the day in less than 3 hours, preferably overnight with lower tariffs or during daytime when combined with PV. Most of the cars are parked overnight at off-street spaces.

Lengthy and complex approval procedures can be a major barrier to owners and tenants installing recharging points in existing multi-tenant residential and non-residential buildings. Obtaining the necessary approvals can create delays or prevent installation. 'Right to plug' or 'right to charge' requirements ensure that any tenant or co-owner can install a recharging point for an electric vehicle without having to obtain (potentially difficult) consent from the tenant's landlord or from the other co-owners.

In several Member States, a resident needs the approval of their co-owners (and/or a third party) to install a charger in their parking space. The Commission Recommendation (EU) 2019/1019 on building modernisation includes the 'Right to Plug' principle to ease the approval process:

"Regulatory barriers and market failures may impede the deployment of electromobility infrastructure and, consequently, the uptake of electric vehicles. Regulatory simplification, long-term planning and financial incentives may be necessary to tackle these challenges. To simplify the deployment of recharging points (Article 8(7) of the EPBD), Member States are encouraged to ensure the 'right to plug' to address split incentives and administrative complications, notably in the case of multi-family dwellings. In addition, Member States are encouraged to consider policy and financial measures also as part of their long-term renovation strategies (Article 2a of the EPBD) which can support and accelerate the deployment of

[15] V1G allows to control the power flow from the grid to the vehicle and adapt its charging schedule and pace according to grid constraint, while V2G goes one step further and allows bidirectional charging: the electric vehicle becomes both a programmable load and a programmable generator.

[16] See also https://www.euractiv.com/section/energy/opinion/eus-buildings-directive-should-give-ev-owners-the-right-to-a-smart-plug/

electromobility infrastructure in existing buildings, both in cases of major renovation (Article 8(2) and (5) of the EPBD) and to meet the minimum requirements for non-residential buildings set in Article 8(3)), taking into account that the situation on the relevant markets over time is likely to develop, gradually overcoming certain current market failures."

The 'Right to plug' concept was integrated in the proposal for revision of EPBD: see section 3.1.2.

Six Member States have already implemented the 'Right to Plug' in their national legislations

- Spain: According to the Onwership law *(Ley de Propiedad Horizontal art. 17.5): "The installation of an electric vehicle recharging point for private use in the building's car park, provided that it is located in an individual garage space, will only require prior communication to the community"*
- France: In the Code of Construction and Housing *(Code de la construction et de l'habitation),* Article L.111-6-4 provides that a community of owners may not oppose the equipment of private parking spaces with charging equipment for electric or plug-in hybrid vehicles, without serious and legitimate reasons.
- Portugal: according to Property Law, any condominium member, tenant or legal occupier may install, with prior notice and at their own expense, charging points for electric vehicle batteries or electrical outlets that meet the technical requirements. New buildings or rebuilt buildings are required to have a charging point or electrical outlet at parking spaces.
- Italy: the Vade mecum for Condominium and Private Recharges *(Vademecum per le Ricariche Condominali e Private)* states the following: "*1) If you have a private parking space it is necessary to distinguish how the electricity supply takes place: a) By installing an electricity meter in the name of that neighbour, a written communication to the administrator of the condominium which will have to take act of the decision taken since no special authorizations are required."*
- Netherlands: the Dutch government is preparing a legislative proposal to implement 'Right to Plug'
- Germany: the residential modernization law (*Gesetz zur Förderung der Elektromobilität und zur Modernisierung des Wohnungseigentumsgesetzes und zur Änderung von kosten- und grundbuchrechtlichen Vorschriften)* will give appartment owners and tenants ve the right to install a charging station in the underground car park or on the property of the house in the future.

3.3. Lessons learnt from Horizon 2020 projects

3.3.1. Overview

The following H2020-funded projects have been proposed by task force members as providing a significant contribution to the paper scope. Although it is likely that this list is not exhaustive, it covers projects represented or mentioned in the task force. A mapping of selected projects is proposed for the two identified domains.

Table 2: Mapping of relevant projects according to the identified building blocks

Building and energy efficiency:			
Heating solutions and new practices			
Data collection and use			
BEYOND	*Data analytics for buildings*	BD4NRG	*Big data energy framework*

- PARITY — *Smart energy contracts and energy communities, smartness value*
- BIM4Ren — *BIM-based tools for fast and efficient renovation*
- SPHERE — *BIM-based digital twin platforms for residential buildings*

Buildings' infrastructure

- accept — *Quality check for energy efficient buildings*
- SPHERE — *Digital twin environment or decision making*
- Triple-A-reno — *Building renovation*
- *Renovation for buildings and neighbourhoods*

Scalability of solutions

- MEZeroE — *Open ecosystem for the development, testing and upscaling of smart and bio-based, human centric envelop products*
- domOS — *Operating system for smart services in buildings*

Buildings and energy communities

The building itself through its interface(s) and value(s)

Smart readiness indicator

- NRG2PEERS — *P2P readiness level*

Enabling technologies

- PARITY — *Blockchain & IoT for more RES integration*
- MERLON — Holistic optimization & DER coordination for local energy communities
- DR-BOB — *Demand response of building blocks*
- MEZeroE — Open innovation ecosystem to develop nZEB envelope solutions

Business Models for designing and assessing the created value

- RESCoop VPP — *Cooperative approach to VPP through open standards, O/S software and collaborative licensing*
- LIGHTNESS — *Engage communities*
- NOVICE — *Business Models for ESCOs*
- SHAR-Q — Sharing of storage capacities
- CREATORS — *Advanced services for LEC*
- frESCO — New BMs for ESCOs and aggregators for residential consumers
- Hestia — *Demand Response in Energy Communities*

Commitment and momentum, the user perspective	
Early adopters	
LIGHTNESS	*Engage communities*
Hestia	*Demand Response in Energy Communities*
eneuron	*Multi-carriers LEC: design, operations, bottlenecks*
LocalRES	*Empowering local REC for the decarb. of the energy systems*
Renaissance	*RES integration and energy communities*
accept	*Empowering communities in the energy transition*
CREATORS	*Services for LEC*
User experience	
MUSE GRIDS	*End user control strategies for affordable local energy independency*
REACT	*User engagement in a local island energy community for island energy independence*
Regulation and welfare, the 'society' perspective	
Regulation	
Hestia	*Demand Response in Energy Communities*
LIGHTNESS	*Engage communities*
CREATORS	*Services for LEC*
Compile	*Decarbonisation of islands through electromobility and energy communities*
MUSE GRIDS	*Maximise local energy independency*
Renaissance	*RES integration and energy communities*
Upscaling to district and city levels	
+CITYxCHANGE	*Positive energy districts*
CREATORS	*Services for Local Energy Communities*
Making City	*Positive energy districts for cities*
eneuron	*Multi-carriers LEC: design, operations, bottlenecks*
LIGHTNESS	*Engage communities*
DR-BOB	*Demand response of building blocks*

3.3.2. Lessons learnt from the REACT project

REACT's objective is to achieve island energy independence through renewable energy generation and storage, a demand response platform, and promoting user engagement in a local energy community. In that respect, the project is developing a technical and business model to demonstrate that these technologies can bring economic benefits, contribute to the decarbonisation of local energy systems, reduce GHG emissions, and improve environmental air quality.

The REACT project confirmed the essential role of the collaboration of socially important people in small communities (in this case small islands) for fostering the acceptance of new renewable technologies at two levels: independent users (single-family homes) and public premises. Collaboration or participation in architectural modifications in private homes and public spaces is indeed determined by social interactions within the community, and by the feeling of trust in the face of new technology. This, in turn, is mediated by the influence that socially relevant people in the community have on it and can greatly facilitate the approval and acquisition of this new technology by most of the community.

Three lessons learnt can be retained:

- Developing trust with important members of the community to encourage technology adoption
- Plan carefully technology installation as islands' idiosyncrasy can hinder regular developments
- Make sure new technology is easy to use and thus facilitates its adoption.

3.3.3. Lessons learnt from the SPHERE project

The 2018-2022 time period in which the SPHERE Project has been developed has coincided with the dissemination and large-scale implementation of the BIM concept, so BIM was not yet mature enough to be taken as a starting point in many cases.
Most tools are currently used for the design and construction phase of the building. As it is usual in today's technological culture, the Operation and Maintenance phase, although presenting the highest economic and environmental costs, remains less considered, which is not optimal: the building process ends usually with the finalization of the construction works, but the actual life of the building starts right after the construction and it continues for decades, a much longer period than the duration of the design and construction phases. Multiple questions emerge during the building life cycle: the users, owners will get used to this technology; but who is taking care of the maintenance? Who is going to provide the hosting service and who is paying for it?

3.3.4. Lessons learnt from the BIM4Ren project

BIM deployment raised a competence and skills issue: the number of professionals able to properly use BIM remains limited. Although the labour force will be able to use the applications, there is currently a lack of professionals (in the standard building sector) who are able to program, install such devices, sensors, etc.
An important effort towards easy apps, being very user-friendly and immediate to use must still be taken. On a larger extent the entire building sector must be trained so that this new approach can be spread out in a democratic way in each residential unit and beyond (e.g.: in big office building in big cities).

BIM4Ren also highlighted the importance of having a very clear distribution of responsibilities and clear coordination and strong communication activities and channels. Providing the appropriate structure and cooperation mode with the management from all involved parties is a key factor to ensure successful outcomes.

3.3.5. Lessons learnt from the PHOENIX project

PHOENIX' objective is to upgrade smartness of existing buildings through an interoperable architecture that will provide services for both end-users and utilities. Through several experiments, the project demonstrates that buildings can both avoid creating additional stress on the grid and, even more important, they can respond to the needs of the grid and assure the power balance.

In the project this is achieved through a network of sensors that allows to plan power shifting and power shaving strategies. The sensors enable the automation of the smartness score, according to the new SRI guidelines. In this way it has been possible in the project to achieve the level of smartness needed to convert a smart building into a smart grid-responsive building.

3.3.6. Lessons learnt from the MERLON project

MERLON has developed an integrated local energy management system (ILESEM) to support distribution grid operation in a high-renewable scenario. The solution places the prosumers at the centre, preserving their comfort and individual preferences while creating a win-win situation among the members of a local energy community and the other involved stakeholders. ILESEM performs optimization at multiple layers, spanning from local generation, demand and storage. The integrated MERLON solution enables the realization of novel community-based business scenarios including the following:

- Local distribution network management
- Provision of security of supplies during emergencies
- Provision of balancing and ancillary services and participation of the Local Energy System in wholesale energy markets.

Some key lessons learnt are included below:

- The deployment and maintenance of the cutting edge IoT equipment necessary for the implementation of MERLON's solution requires close cooperation with the prosumers involved in the project's demonstration activities. Establishing a continuous communication channel between the project partners and the end users, along with their clear understanding of the devices installed at their premises, enabled easier monitoring of the pilot site's installations and the early identification of issues and errors that might affect the system's operation.
- The Living Lab activities taking place in the two MERLON pilot sites (Austria/Strem and Spain/Crevillent) involving end-users and all the relevant stakeholders of the Local Energy System are essential for the implementation of the MERLON's human-centric approach. The living labs play a key role on raising awareness, increasing engagement and willingness for participation in the MERLON activities. This is achieved through providing detailed information about the MERLON concept and solution, and by training the end-users on how and why to participate in an integrated local energy system. Note that all end users and stakeholders are also involved in the evaluation of the MERLON results.
- Additional protection measures within the electricity network may need to be considered for real-life islanding operation and ensure alignment with national regulation.
- Existing regulation poses barriers on experimentation upon innovative business models that MERLON introduces.

3.4. Other related initiatives and innovations

The following initiatives have been reported during the two first TF workshops on the state of the art and on barriers and drivers (collected via Concept board and further elaborated).

Name of initiative / innovation	Relevant inputs
Pilot energy community in Elmen (Luxembourg)	The new Elmen district in Luxembourg is a pilot energy community (EPC RECAST project pilot) and also addresses mobility (central parking, charging facilities)
ETIP/SNET WG1	A paper on electromobility impacts on grids will be published in early 2022
Gridability	Joint venture offering all-inclusive smart grid solutions: 1) fiscal certified, multi-utility, multiple communication channel smart meters 2) An award-winning blockchain-enabled P2P energy optimization and trading platform 3) NZEB interventions and retrofits for both public, private, tertiary and industrial scale projects 4) Energy community building expertise
SRI Topical Group C **(SRI TGC) - first recommendations report**	The SRI TGC first recommendations report from Austria and other Member States as drafted in Jan– May 2020). It explores possible ways for an optimal use of the value offered by the SRI through existing practices and future routes.
IEA EBC Annexes	The IEA (International Energy Agency) Energy in Buildings and Community (EBC) Programme carries out research and development activities towards near-zero energy and carbon emissions in the built environment. These joint research projects are directed at energy saving technologies and activities that support technology application in practice. Results are also used in the formulation of international and national energy conservation policies and standards. The EBC Research Programme is mainly undertaken through a series of research projects, so-called 'Annexes' for duration ranging from typically 3 to 5 years. High Priority Research Themes include refurbishment of existing buildings (Finance, stakeholders and co-benefits); planning, construction and management process reducing the performance gap; low tech, robust and affordable technology; energy efficient cooling in hot and humid, or dry climates; holistic solution sets on a district level.
European Partnership on 'Driving urban transitions	The Driving Urban Transitions to a Sustainable Future (DUT) Partnership aims to address the complex set of urban challenges, which cities and urban communities are facing today, with an integrated approach to offer decision makers in municipalities, companies and society the means to act and enable the necessary urban transformations
European Partnership **on 'People-centric, Sustainable Built Environment')**	The Built4People European Partnership (B4P) is a new industrial partnership between the European Commission, the European Construction Technology Platform (ECTP) and the World Green Building Council (WGBC) to co-programme and co-finance research topics under Horizon Europe. It brings together the whole construction value chain and aims at developing sector-relevant innovation clusters across the EU.
Bridge initiative	Contributions from selected projects dealing with data exchange and interoperability involving building in their demonstrations could produce valuable knowledge.
Horizon Europe call Built4People	The Horizon Europe call HORIZON-CL5-2022-D4-02 deals with efficient, sustainable and inclusive energy use. The topic 'D4-02-04 Smart-grid ready and smart-network ready buildings, acting as active utility nodes (Built4People)'. It will be launched in September 2022 (deadline 24 Jan 2023) and will call for projects whose results will contribute to *'Improved interoperability and synergies between electricity and other energy carriers, and with other relevant non-energy sectors (e.g. mobility), supported by buildings, contribution to energy system integration at building's level and Improved competitiveness of buildings as flexibility assets for grid and network management'*
Eirie platform	eirie.eu large database is a powerful tool for project scanning. The platform unites all R&I stakeholders in one place and can be used to share knowledge and used cases, regulations, standards and lessons learned from successful projects.
Recommendations for a revised EPBD	The letter, among other points on renovation pace and on the strengthening and harmonisation of Energy Performance Certificates (EPC), recommends to support cost-

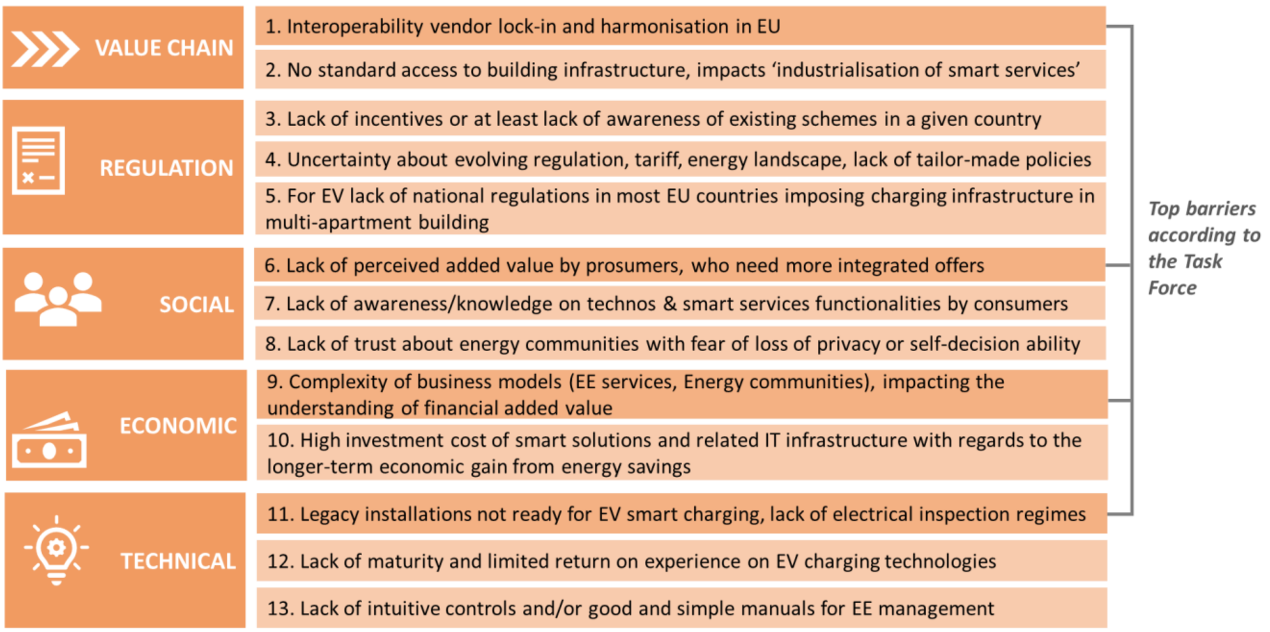
supporting climate neutrality by professional associations, dated October 2021	effective integration of the increasingly electrified building and transport sectors by strengthening the existing e-mobility provisions with mandatory minimum requirements for smart charging points for parking spaces in or nearby buildings, even not undergoing major renovations to avoid unnecessary grid reinforcements following the increase in electrification of end-use sectors. Ensuring the 'right to plug' is highlighted to ease the approval process, and require bidirectional charging functionalities in case of on-site renewable generation Finally the letter recommends integrating the SRI or the Digital Building Logbook to improve energy performance in EPC.

4. Barriers and drivers

4.1. Barriers

Barriers to the market uptake of smart buildings related to the covered scope were reviewed and prioritised by the Task force. The top barriers are highlighted below.

Figure 8: Overview of main barriers



Some additional barriers were suggested during the open consultation process:

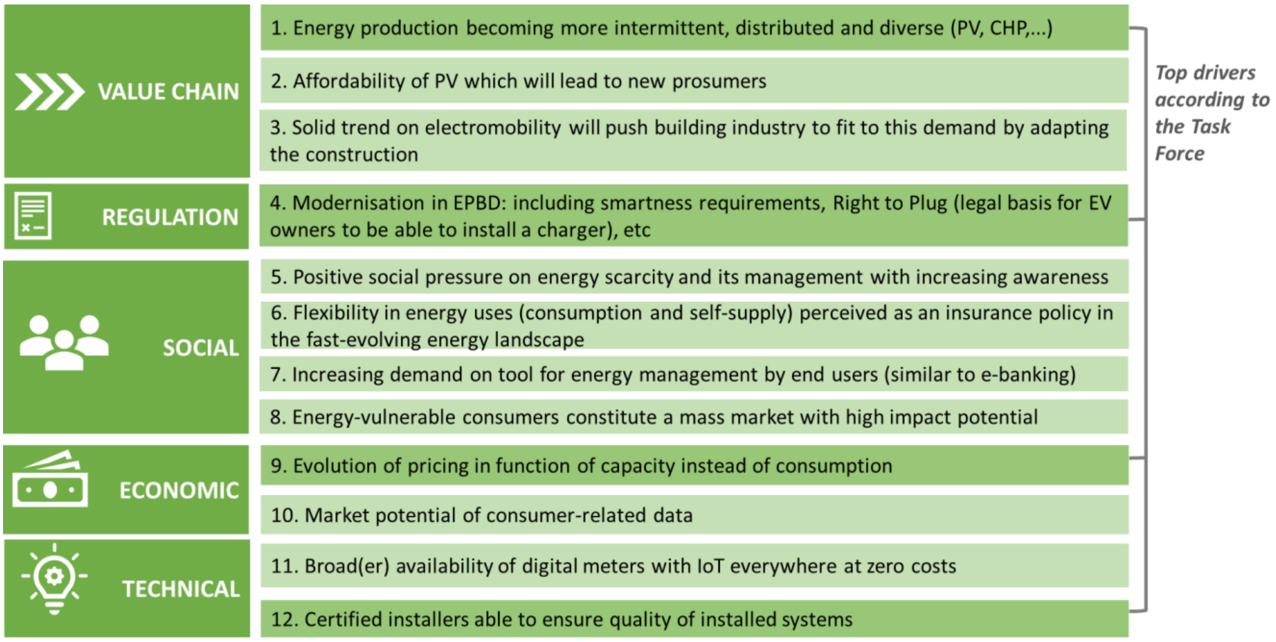
- High demand for human interventions in the application of the smart technologies (for example installing a smart thermostat can require three technicians: a heating engineer, an electrician and an IT specialist which can lead to higher costs.
- Lack of reliability: Interconnected diverse technologies with different tolerance poses can create a risk of failure.
- Difficulty to change consumers routine behaviours.

- Future uncertainty: the impact of uncertainties on the performance of energy community is important. Future uncertainties can influence the renewable energy production, storage systems, etc.

4.2. Drivers

The drivers identified by the Task force are as illustrated below. The strongest drivers are highlighted in reinforced green colour.

Figure 9: Overview of main drivers



Some additional drivers were suggested during the open consultation process:

- Need for self-sufficiency in the buildings
- Social pressure on climate change and its impact on the building sector.

5. Gaps

5.1. Research and development gaps

Type of activity	Activities
R&I	***On energy efficiency***: ▪ Enhancing autonomy of building occupants in operating / optimizing the energy system through the development of dedicated guidelines or training programmes

<table>
<tr><td></td><td>▪ Carrying out extensive literature and research review on the possible energy and cost savings to objectivize the views on the added value.

On energy communities:
▪ Designing novel approaches to encourage trust among citizens to develop energy communities, the mechanisms that can effectively encourage the creation of such communities, as well as the practical guidance to legal or administrative aid can be needed
▪ Developing methodologies to raise citizens' and occupants' awareness about energy communities, their potential impacts, their benefits and more specifically on the process to get involved
▪ Exploring synergic improvement in multi-purpose energy communities and how to maximize the benefits for all the areas[17].</td></tr>
<tr><td>Demo</td><td>On energy efficiency:
▪ Benefits and cost effectiveness comparison between utilising legacy equipment or investing in new equipment to promote energy efficiency
▪ Experimental proof of affordability of IT infrastructure
▪ Effective integration of business models beyond the strict technology
▪ Systematic design of use cases beyond a given technology
▪ Leadership of stakeholders of different natures, for example public sector for energy communities
▪ End user acceptation with respect to smart charging in V1G and V2G
▪ Roadmap of catalogues of solutions (IOT catalogue - example) with 'glocal' choices of options for consumers having in mind how to stack services within energy communities
▪ First building certified by Smart Readiness Indicator. A demonstrator to validate the modalities of certification of a building. This will also constitute an actual implementation of a Smart Readiness Indicator in a building

On Energy communities:
▪ Simple approaches and methodologies for setting up energy communities at citizens communities' level (e.g., group of citizens, neighbourhoods, block of buildings).
▪ An extension of SRI certification on a broader base (strictly beyond SRI)
▪ An exploration of other certification schemes for wide demonstrations.</td></tr>
</table>

[17] see https://doi.org/10.1016/j.esr.2021.100678

5.2. 'Go-to-market' gaps

<table>
<tr><th>Type of activity</th><th>Activities</th></tr>
<tr><td>Regulation & legal framework</td><td>On energy efficiency:
▪ Data transparency should be as in Horizon programmes. Ensure the information portrayed on documentation registering the process and results are easily available and understandable for prospective business or investors.
One Energy communities:
▪ a 'right to plug' for renters and owners, enabling the upgrade of existing dwellings and removing the current barriers to home charging is needed. Indeed, nowadays, in some EU countries, all homeowners must approve the installation of a charging station in a shared building. A 'right to plug' could speed up the rollout of home chargers as it would include provisions to avoid a single neighbour blocking the installation of a plug[18].
▪ Involvement of public governments and policy makers for ensuring a co-funding and the promotion of first commercial projects.
▪ A regulatory sandbox for demonstrations for energy communities.</td></tr>
<tr><td>Certification & standardisation</td><td rowspan="2">▪ Standardisation of smart energy services
▪ Consolidation of (different) service catalogue(s) for the Smart Readiness Indicators
▪ Analyse possible differences in standards between Member States
▪ Reduce the time to market of innovations duration to 3-4 years to foster their impact. In the same idea reducing the time to grant duration of EU-funded projects (currently 8 months) could give to EU innovations more reactivity face to competition.
▪ Systemic approach to stakeholders' interviews prior to the start of solutions design and demonstrations through structured approaches of feedback loop.</td></tr>
<tr><td>Scaling up & industrialisation</td></tr>
<tr><td>Upskilling & awareness raising</td><td>▪ Knowledge on 'Learning curve of next technology and reduction of cost' according to scale
▪ Lessons learnt from Social Science and Humanities on new energy practices to facilitate the route from early adopter to massive adoption
▪ Access to well-documented success stories. Indeed, documented demonstrations could be used to incentivise commercialisation.</td></tr>
</table>

Some additional R&I topics were suggested during the open consultation process:

- Interaction with energy community: a building can have interaction with other buildings or the grid. It is important to consider the neighbour buildings demand before interacting with the grid. This can maybe prevent the grid stress, etc.
- Experiments: more attention should be paid to experimental proof of usability of smart buildings including lots of smart technologies.
- Standards: developing standards for concepts such as energy flexibility as one of the main goals of energy community
- Growing share of electrification: the future trend for building electrification (all-electric buildings) should also be considered when developing energy communities.

[18] https://www.euractiv.com/section/energy/opinion/eus-buildings-directive-should-give-ev-owners-the-right-to-a-smart-plug/

- More attention is needed on the building users as the most important factor inside the buildings. Habits of using the appliances and EVs are important, and reactions to signals from some external factors such as dynamic pricing tariffs.
- Development of Smart Energy Management Systems targeting a usage by energy communities.

6. Conclusion

This document formalises the collaborative work performed by the members of SmartBuilt4EU task force 3, on a voluntary basis, during the period October 2021- May 2022. An open consultation process took place in April-May 2022.
Based on an analysis of the state of the art and the identification of barriers and drivers, the main objective of this paper is to detect some Research and Innovation gaps that still need to be addressed in the coming years in order to foster the adoption of new energy practices and communities through smart buildings solutions.
This White Paper will feed the elaboration of the Strategic Research and Innovation Agenda that the SmartBuilt4EU consortium will present to the European Commission.

Task force 3 will investigate one more topic during 2022: next topic, starting May 2022, focuses on data driven indicators for smart buildings.

If you have some expertise to share on this topic, you are invited to join the task force and contribute to the next White Paper (contact detail below).

To receive the updates on the SmartBuil4EU task forces, White Papers and events, please register here: https://smartbuilt4eu.eu/join-our-community/

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Annex 1: list of H2020 projects related to the task force topic

Table 3: List of identified EU funded projects

Project	Status	Contact in TF	Weblink	Relevant inputs
BEYOND	Ongoing	John Avramidis	https://beyond-h2020.eu	BEYOND introduces a reference big data platform implementation for collecting, processing and analyzing building data, while transforming them into a tradeable commodity through the development of appropriate data sharing mechanisms for data sharing between different stakeholders. The data consumers are thus empowered to run analytics and simulations that are actually needed to design a project and exploit them during the real-time operation of the buildings so as to optimize their operation and energy performance.
VICINITY 2020	2016-2020	-	https://vicinity2020.eu/	The VICINITY project aims to build and demonstrate a bottom-up ecosystem of decentralised interoperability of IoT infrastructures called virtual neighbourhood, where users can share the access to their smart objects without losing the control over them. The ubiquitous interoperability will allow independent value added

				services across IoT domains. The open virtual neighbourhood network to connect IoT infrastructures and smart objects will enable to offer "Interoperability as a Service".
SHAR-Q		Natalie Samovitch	http://www.sharqproject.eu/home	SHAR-Q: Storage capacity over virtual neighbourhoods of energy ecosystems. Sharing of storage capacities deployed at distributed locations is expected to reduce the Electrical Energy Storages (EES)capacities needed, bringing significant savings on the required storage capacities and thus unit costs. The project aims to establish an interoperability network that connects the capacities of the neighbourhooding and wide regional RES+EES ecosystems into a collaboration framework, that mitigates the requirement on the overall EES capacities thanks to the shared capacities among the participating actors.
smart en city		-	[SMARTEN CITY]	SmartEnCity aims to develop a highly adaptable and replicable systemic approach towards urban transition into sustainable, smart and resource-efficient cities in Europe. Three Lighthouse demonstrators (Vitoria-Gasteiz in Spain, Tartu in Estonia and Sonderborg in Denmark) are deployed for further refinement and replication. Examples: i) the retrofitting package and a Smart home solution in Tartu. ii)The Vitoria-Gasteiz retrofitting package complemented with an urban management system in Vitoria-Gasteiz. iii)The new intelligent rechargers that will be installed in Sonderborg's private homes, companies as well as public locations are remote controlled to ensure that EVs are charged when electricity prices are the lowest.
PHOENIX	Ongoing	-	[PHOENIX]	Upgrading smartness of existing buildings through innovations for legacy equipment. PHOENIX will build an interoperable architecture with advanced capacity to incorporate and process all kinds of building data and knowledge to improve the intelligence of services offered to end-users and stakeholders. It will design a portfolio of ICT solutions covering all aspects from hardware and software upgrades needed in legacy equipment and optimal deployment of sensors, to data analytics and services for both building users and energy utilities.
REScoop VPP		-	[RescoopVPP]	REScoopVPP develops a cooperative approach to Virtual Power Plants through open standards, open source software and collaborative licensing of smart energy management tools with high standards for data protection while maintaining independency from commercial interests. It will deploy large-scale experimentation in Belgium, France, Germany, Spain and the UK. Each of these pilot sites fulfill a specific function and business model in the context of a real electricity market actor. See pilots https://www.rescoopvpp.eu/pilots
ASCR Aspern Smart City Research THE FUTURE OF ENERGY IS ALREADY HERE	Launched in 2013	-	[ACSR]	Aspern Smart City Research GmbH & Co KG is the largest and most innovative energy research project in all of Europe. Launched in 2013 ASCR uses real data from the urban development zone of Aspern Seestadt to explore solutions for the energy future of cities. Subjects of research include demonstration of smart buildings equipped with photovoltaics, solar thermal energy, hybrid systems, heat pumps and thermal and electrical storage units and communicating with each other; communal electricity production in energy districts; the digital building twins, both during the planning and construction phase and during operation.
Hestia	ongoing	-	[Hestia]	HESTIA contributes to "Empowering communities in the energy transition" and proposes a holistic DR for residential communities in Europe. In Berchida demo: the municipality as grid owner will implement smartgrid: results of the 30-household demo over a 3000 inhabitants village will be scalable for small

				/medium size cities in EU (with municipalities owners of grid). It shall increase residential consumers engagements
NOVICE	ongoing	-	https://novice-project.eu/	Develop and demonstrate an innovative business model for ESCOs that will provide energy savings and DRF to the renovation of buildings
MUSE GRIDS	ongoing	-	https://www.muse-grids.eu	Test and implement technological and non-technological solutions that enable maximization of affordable local energy independency thanks to optimized management of the production via end users centered control strategies, smart grid functionalities, storage and energy system integration: -V2G / V2B, -SETS (Thermal storage tank for water and space heating), -Large insulated water tanks
BD4NRG Big Data for Next Generation Energy	ongoing	Natalie Samovitch	https://www.bd4nrg.eu/	BD4NRG deploys a distributed big data energy analytics framework
MERLON	Ongoing	Angelina Katsifaraki	https://www.merlon-project.eu/	MERLON proposes a holistic optimization & DER coordination for local energy communities: -BESS integration and interconnection at key network locations of integrated local energy systems (ILES) -Optimal coordination of local flexibility resources -Grid balancing via flexibility-induced self-consumption leading to VRES curtailment elimination -Contribution to the establishment of LECs -Establishment of locally organized flexibility markets with transparent market transactions and benefit sharing among all stakeholders -Investigation of innovative business models -Empowerment of local energy stakeholders and the establishment of viable business cases upon innovative clustered structure based on ILES
eneuron	Ongoing		http://eneuron.eu/	Local energy Communities (LEC) offering energy transitions and using energy generated to tackle bottle necks in communities . Optimising the design and operation of local energy communities based on multi-carrier energy systems http://eneuron.eu/showcases/ shows proposed pilot cases
SYNERGY	2020-2023	Natalie Samovitch	https://www.synergyh2020.eu/	Using big data to address the issues in the energy sector and proposing energy as a service using an ICT platform
LocalRES	Ongoing .	Athanase Vafeas	https://cordis.europa.eu/project/id/957819	LocalRES contributes to empowering local renewable energy communities for the decarbonisation of the energy systems. It will deploy innovative local energy systems to put renewable energy into the hands of communities and people. The project will boost structural changes in the current energy system at different levels: generation, market, distribution and consumers. To this aim, the project will develop a planning tool to

				enable citizen participation in the renewable energy communities' planning and decision-making processes, and a Multi-Energy Virtual Power Plant (MEVPP) approach for optimising in real-time different energy vectors (electricity, heating, mobility) and different energy and flexibility services. Empowering local renewable energy communities for the decarbonisation of the energy systems.
PARITY	oct 2019 to March 2023 Ongoing	-	https://cordis.europa.eu/project/id/864319	PARITY stands for Pro-sumer AwaRe, Transactive Markets for Valorization of Distributed flexibilITY enabled by Smart Energy Contracts. It aims to address the “structural inertia” of existing distribution grids by delivering a transactive grid & market framework. PARITY will go beyond the traditional “top-down” grid management practices by delivering a unique local flexibility market platform through the seamless integration of IoT and blockchain technologies. By delivering a market for automated flexibility exchange based on smart contracts & blockchain, PARITY will facilitate efficient and transparent local flexibility transactions and reward flexibility in a cost-reflective and symmetric manner, through price signals based on real-time grid operational constraints and available DER flexibility.
IElectrix	2019-2022	-	https://ielectrix-h2020.eu/	In response to the call: “Integrated local energy systems (Energy islands)” that addresses the challenge of a single and smart European electricity grid in integrating renewable energy sources, the project aims to: Increase RES integration into the network; Connect Local Energy Communities to MV & LV networks; Build flexible and smart micro-grids; Increase grid resilience and thereby security of supply; Improve consumers’ involvement (prosumers); Develop innovative and sustainable technical solutions and business models
Compile	Nov 2018-OCt2022	-	https://www.compile-project.eu/#	The main goal of COMPILE is to show the opportunities of energy islands for decarbonisation of energy supply, community building and creating environmental and socioeconomic benefits. The EU project seeks to showcase the opportunities for decarbonization of energy islands via: 1. Creating decentralised Energy systems 2. Control Electromobility to ensure decarbonisation and energy saving. 3. Foster Energy Communitties creation.
Renaissance Renewable integration and sustainability in energy communities	Ongoing march 2019 and ends in October 2022	-	https://www.renaissance-h2020.eu	Renaissance project is an Innovation Action (IA) which aim is to deliver a community-driven scalable and replicable approach, to implement new business models and technologies supporting clean production and shared distribution of energy in local communities. Renewable integration and sustainability in energy communities. EU Project , with a goal to support Industry leaders and energy platforms to deliver energy with a market focus across Europe . it will work with the energy networks to achieve reduced energy price . It aims through 4 pilot sites in the Netherlands , Spain, Greece and Belgium(Brussels) to : 1. Create Energy Communities that support Energy Efficiency for different energy sectors based on its pilot projects . 2. The models used will be frameworks for that can be replicated.
LIGHTNESS **engaging communities in the future of energy**	Ongoing	Marten Boekelo	Lightness	The Lightness project aims to empower citizens to generate, share and sell renewable energy and thereby contribute to making the European energy sector more sustainable and democratic. It will - Analyse the needs and opportunities of each context and involve end-users, professionals and policy makers, - Facilitate local engagement processes and support citizens to generate and exchange renewable energy themselves, - Provide technological devices and monitoring tools to reduce energy consumption and CO2 emissions, - Issue

				policy recommendations and guidelines for governments, - Raise broader awareness on the just energy transition Just creation of ECs + gamification : Has some attention to 'gamification' as strategy to promote flexibility, but really most of the project is about creation and growth of smart energy communities. So further into the bottom right corner.
CREATORS Creating Community energy Systems	Ongoing	-	CREATORS	The project enables local initiators to create and operate advanced Community Energy Systems (CES) by supporting technical, financial and social processes. Indeed local CES initiators lack the capacity for high-quality simulation, business modelling and automated operations that are required in communities with a range of vectors, 1000s of mixed members, and balancing/ trading that requires controls in milliseconds. Leading engineering firms Cordeel and COMSA work with specialists in simulation and energy trading (i.LECO) emulation for digital twins (Typhoon HIL), and financing (EnergyPro) to develop services that enable local professionals to apply state of the art energy system technologies. These applications and integrated packages will mature from TRL5-6 to TRL7-8 and eventually be offered as ´CES-as-a-Service´. The services will deliver 60% preparation and operational costs reductions, ensuring 99,95% uptime, 20-35% CAPEX reduction, and up to 40% additional incomes. The results are 5-10% local energy price reduction.
REGEN by 2		-	https://www.regen-by-2.eu/	REGEN-BY-2 will develop a novel multi-generation, all-in-one integrated energy plant capable of converting any type of RES thermal source, from low to high-temperature, in energy vectors such as electric, heating and-or cooling powers, thus enabling the simultaneous supply to multiple typologies of end-users with different energy demands. The result will be a highly efficient turnkey multi-generation, all-in-one Combined Heating and Power (CHP), Combined Cooling and Power (CCP) and Combined Cooling Heating and Power (CCHP) device.
+CITYxCHANGE : co creating positive energy districts			https://cityxchange.eu/	+CityxChange develops feasible and realistic demonstration projects in climate-friendly and sustainable urban environments. The demonstration projects are developed in the Lighthouse Cities (Limerick, Rep. of Ireland and Trondheim, Norway) and will be replicated in five Follower Cities (Alba Iulia, Romania; Sestao, Spain; Pisek, Czech Republic; Smolyan, Bulgaria and Voru, Estonia). Demonstrations consist in - enabling a common energy market, - creating connected communities, - recommendations for new policy interventions, market regulations and business models.
Making City Positive energy districts	2018-2023	-	MAKINGCITY	MAKING-CITY will address and demonstrate the urban energy system transformation towards smart and low-carbon cities based on the Positive Energy District (PED). A PED is defined as “a district with annual net zero energy import and net zero carbon emissions, working towards an annual local surplus production of renewable energy” in the SET Plan. Technologies used include-Retrofitting buildings to maximize infrastructure performance, -Increase renewable sources to produce self-sufficient green energy, -Design, adapt and upgrade heating and cooling systems, -Deploy storage and transfer systems to anticipate energy demand peaks, - Set up public charging stations to boost electric mobility

NATURE 4 CITIES Renaturing cities		-	N4CITIES	The project fosters sustainable urban planning thanks to a Nature Based Solutions knowledge diffusion and assessment platform for re-naturing cities. It creates a comprehensive reference Platform for Nature Based Solutions (NBS), offering technical solutions, methods and tools to empower urban planning decision making.
NRG2 PEERS	Ongoing	-	NRG2peers	The project aims to establish and run real local energy communities of peer-to-peer energy traders and share lessons in different European Member States.
Interreg North-West Europe cVPP	2017-2022	-	cVPPs	Interreg project on community-led VPPs, consisting in incorporating distributed power sources into a cVPP to improve grid stability and enhance the energy market efficiency at a local scale. A community-based Virtual Power Plant (cVPP) facilitates local community energy initiatives to aggregate distributed generation and flexibility through an Energy Management System (EMS) platform which models price changes, energy flows and weather conditions, and thereby helps to solve the grid problems. Being organized by the community and driven by their needs, a cVPP works for citizens: it enables energy communities to manage energy demand and supply within their community and to trade energy and flexibility on markets, which helps democratise the energy system.
DR-BOB	2016-2019	-	DR-BOB	Demand Response In Blocks Of Buildings: A cloud-based Energy Management System (EMS) enabling maximisation from demand response while minimizing energy consumption and carbon emissions. This IT solution is a scalable and applicable to single and multiple blocks of buildings. It provides the ability to maximise revenue from demand response while minimising energy consumption and carbon emissions.
SPHERE	Ongoing	Mikel Borras	SPHERE	A BIM-based Digital Twin Platform to optimise the building lifecycle, reduce costs, and improve energy efficiency in residential buildings. The SPHERE cloud-ICT platform will allow to interact all different stakeholders during any phase of the asset with a building Digital Twin model of information of the building and a scalable set of different software tools, such as energy demand/performance simulation tools, Decision Support and Coaching Systems, BEMs or IoT enabled Predictive Maintenance Algorithms.
SYNERGY	Ongoing	Natalie Samovitch	SYNERGY	The EU-funded SYNERGY project will develop a Big Energy Data Platform (Big Energy Data Platform) and an online AI Analytics Marketplace (AI Analytics Marketplace).
FLEXCoop	Completed		FLEXCOOP	FLEXCoop introduces an end-to-end Automated Demand Response Optimization Framework. It enables the realization of novel business models, allowing energy cooperatives to introduce themselves in energy markets under the role of an aggregator. It equips cooperatives with innovative and highly effective tools for the establishment of robust business practices to exploit their microgrids and dynamic VPPs as balancing and ancillary assets toward grid stability and alleviation of network constraints.
frESCO	Ongoing	-	FRESCO	New business models for ESCos and agregators for residential consumers. frESCO aims to integrate existing big data technologies, tools and libraries, with energy-relevant legacy systems and ICT-enabled assets and

				components to accelerate the data management and analysis cycle for powering the frESCO innovative services, turning the 4 Big Data V's into Stakeholder Value
		Natalie Samovitch	INTERCONNECT	Interoperable solutions connecting smart homes, buildings and grids: co-creations processes with end-users planned in each demo, design thinking
	2021-2025 Launched June 2021	Amin Moazami (NTNU)	COLLECTiEF	EU-H2020 COLLECTiEF - Collective Intelligence for Energy Flexibility. The H2020-funded project aims to implement an interoperable and scalable energy management system to smart up buildings and their legacy equipment on large scale. It will enhance, implement, test, and evaluate an interoperable and scalable energy management system based on Collective Intelligence (CI) that will be integrated into existing buildings and urban energy systems aiming to reduce installation cost, data transfer and computational power while increasing data security, energy flexibility and climate resilience. The system will be installed in four pilot sites (France, Italy, Norway, Cyprus), with a total of 13 buildings and one living laboratory representing 40% of different building archetypes in Europe with different uses, scales, markets, and climatic contexts to demonstrate replicability and scalability of the solution.
	On going	-	https://www.accept-project.eu/	"Empowering communities in the energy transition". The ACCEPT project is the concept of "energy communities" with the collective approach to bring citizens, local businesses and organizations together, to produce and consume locally generated, renewable energy. The EU-funded project intends to develop and deliver a digital toolbox, that allows such energy communities to offer innovative digital services to reduce the dependency on fossil fuels, save energy in the users households and thus be able to reduce their electricity bill without compromising the quality of living, but ideally increasing the comfort in their homes through smart devices. In ACCEPT, these developed tools will be demonstrated and validated in four pilot sites in Greece, the Netherlands, Spain and Switzerland involving more than 3.000 people and 750 residences.
		-	3RENO	TripleA-reno: Attractive, Acceptable & Affordable deep Renovation by a consumers orientated and performance evidence based approach
		Fausto Sainz	BIM4REN	BIM-based tools for fast and efficient renovation. The project will define digital ready renovation workflows adapted to the construction sector needs and elaborate an open, decentralized BIM environment as strong innovative basis for the core developments. Methodologies, processes and hard technologies will be developed for data collection, data management and data driven design. Finally, a One Stop Access Platform will integrate all technologies as a single-entry point to all end users. Impact will be ensured through standardization activities, training of hand-crafters and SMEs and demonstration on pilots used as living labs.
		Laura Vandi (Focchi)	RENOZEB	Accelerating nearly zero energy renovation for buildings and neighbourhoods. RenoZEB aims to unlock the nearly Zero Energy Building (nZEB) renovation market by increasing property value through a new systemic approach to retrofitting. This will include innovative components, and processes and decision-making methodologies to guide all value-chain actors in the nZEB building renovation action. RenoZEB will provide cost-effective 'plug and play' solutions for a large-scale deep nZEB rehabilitation schemes, ensuring the integrate-ability of all its components, methodologies, training, guidelines, and demonstration cases. The real and virtual demonstration

			cases will show and ensure the replicability of the schemes and technical tools to appropriately address the valorisation of the building stock before and after nZEB renovation schemes are applied.
	Laura Vandi (Focchi)	MEZEROE	The project address the measure of envelope systems for Zero Energy buildings. It aims to develop a European open innovation ecosystem to develop nZEB envelope solutions, transfer knowledge, match test demand and offer, monitor living labs and standardize cutting-edge solutions.
	Gabioud Dominique	domOS	Operating system for smart services in buildings
	Fausto Sainz	REACT	REACT objective is to achieve island energy independence through renewable energy generation and storage, a demand response platform, and promoting user engagement in a local energy community. For that the project is developing a technical and business model to demonstrate that these technologies can bring economic benefits, contribute to the decarbonization of local energy systems, reduce GHG emissions, and improve environmental air quality.