PRESENTING THE VALUE OF FLEXIBLE BUILDINGS

smartEn Q&A paper

April 2021

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Smart Energy Europe

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The democratisation of energy – the role of flexible buildings

Our climate is changing at an ever-increasing pace. Many suggest that if we do not take sufficient action ***this decade*** then it could accelerate even faster. Therefore, timing is a highly important factor in working out how we can de-carbonise energy and achieve climate neutrality by 2050 in the most cost-effective way.

Consider then, this suggestion…

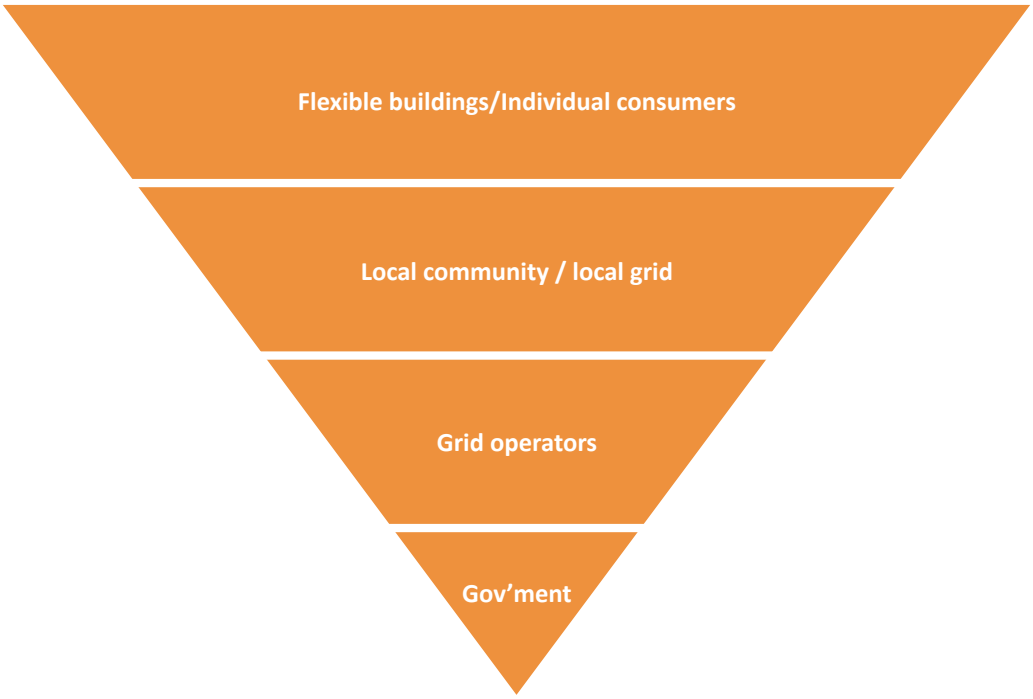
It is the everyday decisions of individuals that will deliver a significant portion of climate neutrality – that is all individuals: politicians, business leaders, celebrities, consumers – everyone.

Politicians always have an eye on their voters, business leaders on their brand, celebrities on their popularity and consumers on the opinion of their friends and family.

Thus, **climate neutrality will be consumer led by the decisions we all make** when electing politicians, making business decisions, buying products, choosing our priorities, making day-to-day choices: the whole is made up of the sum of the parts and the sooner this accelerates the better.

Perversely, the more centralised decisions and operations are, the less responsibility consumers – business and domestic - take. Out of sight equals out of mind so everyday decisions may disregard their impact on climate neutrality. Thus, centralisation could make climate neutrality less, not more, likely… or much longer to achieve with the consequences that entails.

What then if we looked at the supply and use of energy from a different perspective, taking an "inverted pyramid" viewpoint that starts with a consumption perspective.



Flexible buildings have the ability to improve the delivery of climate neutrality in energy terms by bringing decisions closer to the user: i.e. the democratisation of energy- making flexible buildings an important part of achieving the clean energy transition to the benefit of all Europeans.

The present Q&A document aims at providing clear, concise answers to fundamental questions that should be replied in view of the "Fit for 55 package" that should set an ambitious EU legislative framework for this decade to support climate neutrality in 2050. Flexible buildings should be a pillar of this package and the present document explains why.

1. What is a flexible or active building?

It is a building that operates as an active part of the energy system rather than just a consumer of energy. **It is able to interact and support its occupants and the grid by varying its energy consumption,** generation and storage of energy and, in some cases, supply electricity to the grid in response to signals from the grid **and the (local) energy markets.** The result is an increase in overall system efficiency as well as the energy efficiency of the building itself.

2. How can active buildings flexibly adapt their energy consumption to external signals?

The core of a flexible building is a Building Energy Management System (BEMS) or a single smart controller that responds to signals from the grid and controls technical building systems and/or a set of home appliances to increase or decrease demand, generate and store energy, and where possible supply energy to the grid.

There are two main types of signal:

1 *Implicit* pricing signals in the form of variable tariffs, both static and dynamic. Where smart meters are fitted, these signals can be fed directly to the BEMS or the smart controller. They then adjust the building's consumption depending on its current situation: e.g. critical peak shaving by reducing air conditioning temperature settings, deferring EV charging etc. where these systems are installed.

2 *Explicit*, contractual requirements to vary demand/supply passed direct to the smart controller. This is handled by energy service providers called Aggregators which sell this flexible adjustment of consumption/ production to the different electricity markets. Currently this mainly works with industrial complexes due to the small number and widely distributed nature of flexible resources in residential and smaller commercial buildings. The electrification of transport and heating will change this, with the flexibility they offer also potentially increasing their penetration by improving system efficiency and thereby reducing the need to strengthen local distribution networks.

Finally, as buildings can be part of local energy communities, they can receive signals from the local exchange among buildings part of the same community, enabling occupants to trade with each other, optimising benefits for them and the grid, in line with the EU's new emphasis on consumer-centric energy communities.

3. What are the smart technologies in buildings and data-driven energy services that can enable their occupants to activate their demand-side flexibility potential?

Both types of signal (implicit and explicit) require a set of appropriate Distributed Energy Resources to function. These can be:

- Controllable loads, larger ones such as heating and EV charging, but also a larger number of smaller loads such as fridge/freezers, laundry appliances etc. where the actual timing of their operation can be varied. Currently the majority of flexible response is provided by the C&I sector through control of large technical equipment, processes and stand-by generation.
- Storage devices that can increase their demand when prices are low or collect excess self-generated energy when it is not required by the grid (water storage systems or electric vehicles) as well as devices that can import and export electricity on demand (home batteries and electric vehicles capable of Vehicle-to-Building or Vehicle-to-Grid functionalities).
- Small scale variable renewable generation assets installed on buildings or nearby as photovoltaics.

Such resources need to be digitally connected among themselves and with the surrounding system to be capable of adjusting their consumption and production automatically.

Data-driven energy services, as demand response aggregation, can support the smart interaction of behind the meter assets with both grids and electricity markets. Hundreds of thousands of consumers, aggregated together, can provide hundreds of MW of load reduction as an alternative to traditional generation, thus avoiding high system costs and CO2 emissions. In Europe, by 2030, millions of consumers with flexible loads in their buildings could participate, totalling a potential of over 160 GW[1] for all kinds of electricity users, most of which among households.

4. How can digitalisation help the evolution of buildings from passive to active players in the clean energy transition?

Digitalisation enables demand-side flexibility. There is a need for a certain level of smartness in buildings, i.e. capabilities to continuously monitor and manage energy flows, to process signals from the grid and control building systems accordingly. In addition, digital communications such as smart meters and IoT/IoE[2] are needed to integrate multiple assets, to manage data and pass signals/instructions.

[1] By 2030 (source: European Commission, Evaluation report, SWD(2016) 412 Final, part 2/2, p.168).

[2] Internet of Energy (IoE) which differs from IoT in that IoE devices are normally permanently installed in buildings, have multiple users during their life cycle and therefore require different support mechanisms.

5. How are data privacy and cybersecurity respected in smart buildings?

The clean energy transition will not take place without the support of digitalisation. Data privacy and cybersecurity of energy-smart appliances must be ensured and guaranteed, as is the case with all data transformations: smart buildings are no different.

All energy-smart devices in buildings will need to be compliant with all relevant regulations and standards to respect data privacy and cybersecurity. In particular, cybersecurity protection needs to be embedded in the active control devices, data transfer should be encrypted to ensure data privacy and secure protocols must be used by service providers.

6. How can renewable electricity penetrate the building sector while increasing energy efficiency?

In a building, the conventional way to improve energy efficiency is to reduce energy demand by, for example, improving insulation, fitting more efficient heat sources or deploying building automation and controls systems (BACS) that can automatically optimise energy consumption.

Additionally, in seeking climate neutrality we also need to minimise the amount of energy from fossil fuels ("black" energy) used by both the overall energy system (including energy generation, distribution and consumption) and the building itself, which is where the maximisation of the use of renewable energy comes in and hence, flexibility. Furthermore, we also have to think about EV charging as part of building's services: traditional energy efficiency alone will do little to address this growth in demand whereas renewable electricity in conjunction with flexibility can reduce grid demand.

Different buildings have different potential for energy efficiency and therefore delivering carbon efficiency. This is particularly so with respect to legacy buildings: some may have the potential for renewables and storage but will be hard to fully insulate, whilst others may be far easier to insulate but not have the correct roof space for solar panels. Here there are distinct benefits in being able to take a wholistic approach to a local area or community. This is where system efficiency becomes highly valuable.

This importance is of even greater value given the electrification of heating and transport. These developments greatly increase the required electrical capacity of buildings and therefore the probability of requiring to use "black" electricity, particularly at peak times or when weather conditions reduces the amount of available renewables. An energy-efficient active building would be able to use less of this "black" electricity as it controls the Distributed Energy Resources in the most efficient way.

Thus, a flexible or active building works alongside traditional energy efficiency to maximise the ***Carbon Efficiency*** of buildings. It is this system efficiency approach to renovation and new construction that will deliver the best contribution to 2050 carbon neutrality.

7. Can the system cope with the increased electrification of both buildings and transport sectors at the same time?

An electric vehicle can double the amount of electricity used by a residential property; the electrification of heating can treble electricity consumption. Applying energy efficiency measures and actions on the demand-side could significantly reduce grid overload. Improved energy management practices bring electricity demand and supply closer, and help electricity end-users get benefits for reducing their demand. They can get better control their energy use, through automated controls, and take measures to reduce capacity need, leading to more favourable electricity prices[3]. Load adjustments with energy management systems and connected sensors can automatically try to ensure demand matches supply seeking to avoid creating grid constraints. However, the scale of the expected growth in demand even with such systems will put significant stress on local LV Distribution Systems, especially where older specified substations are in use[4]. The cost, timescale and level of disruption for upgrading such substations and supply cabling could be very significant if the increased electrification of buildings and all end-use sectors is not flexibility-ready. On the other hand, local flexibility delivered by a collection of active buildings could provide a simpler, faster way (remembering that time is of the essence) to enable keeping loads under control locally and the decarbonisation of energy as a whole. The European Commission calculated saving 5bn Euro/year at distribution system level thank to the activation of distributed flexibility. These are savings resulting from unnecessary investments in grid reinforcements, back-up generation and fuel costs.

8. What are the benefits of active buildings?

There are a number of benefits depending on the perspective taken:

- The biggest benefit to the occupier (residential and commercial) is **reduced energy costs**. Peak electricity demands peak prices. In addition, storing "off-peak" energy reduces the consumption of peak energy generating further benefits[5].

[3] Craig B. Smith, Kelly E. Parmenter, in Energy Management Principles (Second Edition), 2016.

[4] e.g. UK Power Networks "Framework for underground networks" reviewed 31/12/2014 uses a figure of 1.5KW daytime ADMD (After diversity maximum demand) for a 3-bed gas central heating dwelling see: *https://www.ukpowernetworks.co.uk/internet/asset/3de30a5b-8ab2-42db-95a4-994a5ce5f0bH/UKPN_G81_Design_Planning_Appendix_v1.0_kk_040711.pdf*

[5] A study conducted by Green Energy Options Ltd in 2018 with Berkley Homes demonstrated savings of up to 50% for an active home without solar panels and over 50% where fitted with solar panels.

- Reducing peak energy demand and flexibly consuming variable renewable energy have a direct impact on **reducing a property's carbon footprint** and therefore appeals to the growing number of consumers that are interested in taking climate action. Flexible buildings can also enable occupants to select a preferred energy source and thereby additionally support the clean energy transition.
- With particular regard to the residential sector, active homes increase the **affordability** of such homes both by reducing energy costs and reducing rent/mortgage costs through reduced construction costs, sustainable investment, the use of green mortgages and other incentives. This has the potential to reduce fuel poverty.
- Allowing DSOs to address, at local level, network constraints associated with variable generation and new loads, by using flexibility from active buildings, could significantly **reduce network costs and grid investments.** At EU level, avoided investments at distribution level can be of the order of up to €5 billion per year up to 2030[6].

In short, active buildings offer substantial contributions to the cost-effective achievement of climate neutrality.

9. Can we quantify the actual performance of active buildings, notably their carbon footprint and their demand side flexibility?

All buildings are metered and active buildings will include smart meters plus at least one controller which will collect data. It is therefore a relatively simple matter to convert consumption, be it from the grid or behind the meter generation sources, to its carbon content.

In addition, a building's contribution to the local area grid can be metered and converted to its carbon content and thus its contribution to the carbon efficiency of the local area grid system made transparent.

Such a measurement would be continuous rather than a one-off assessment therefore enabling regular monitoring of building performance and the ability to identify if performance was to fall away.

The additional advantages of such a measurement are that it is practical, relatively easy to implement, output based and would encourage innovation to deliver improvements.

[6] *https://ec.europa.eu/commission/commissioners/2019-2024/simson/announcements/speech-commissioner-simson-smart-energy-europe-smarten-online-symposium_en*

10. Is the cost too high?

A regular concern that is expressed about flexibility is that the cost of the assets needed is too high for consumers to invest in.

However, in our buildings there are plenty of "non-dedicated assets" that can become flexibility assets. There are already existing appliances and increasing numbers of new "non-dedicated assets" encouraged by other policies such as renewable heating, electric vehicles and smart appliances that can provide flexible loads in addition to their primary purpose. No upfront costs are involved if they are already deployed, as they simply need to be activated, indeed, flexibility can increase their penetration.

Nevertheless, there are financial barriers to the deployment of new smart and flexible assets in our buildings. Costs can be relatively high, due to the low volumes at this early stage in the market, whilst the revenues that can be earned from the activation of their flexibility are depressed. Also, a significant amount of consumer understanding and attention is needed to integrate them properly which is a major barrier. Key is to ensure both that individual technologies are integrated to make it simpler for the consumer and that multiple markets are established to allow distributed flexibility to be remunerated; among these new markets, Distribution System Operators should be incentivised to procure flexibility services from smart buildings and reward them appropriately.

Peer-to-peer trading, dynamic time of use tariffs and offers for aggregation services to residential and small business customers should be also enabled to both reduce electricity bills and reward participating end-users.

In addition, EU recovery funds should support the development and operation of smart buildings. Within the 37% of green spending, as requested in the Recovery and Resilience Facility, a large share should be allocated in the national plans to flexible buildings and the sectorial integration with transport through direct clean electrification.

11. What is needed to deliver active buildings at scale?

The development of active buildings needs a regulatory push and a wholistic approach to renovations framed around the following priorities:

- **Integrated planning.** All building developments and renovations are subject to planning permissions and it is here that immediate changes should start. All new developments and renovations should be required to foster the interaction of buildings with the system to unlock their distributed flexibility. Planning should foster integration, not isolation of buildings.

  Group renovation schemes provide focus and scale. For example, the Greater London Authority Retrofit Accelerator for Homes Programme[7] is currently deploying a group of schemes around social housing and has invited the

[7] See: *https://www.london.gov.uk/what-we-do/environment/energy/retrofit-accelerator-homes*

private sector to provide them. A similar approach could be taken to area regeneration schemes. By grouping, installation costs can be minimised, assets concentrated (maximising system efficiencies), economies of scale can be delivered, skills and support services are easier to provide and scale up, planning and approvals are simplified and disruption is minimised.

- **Carbon efficiency objective.** A digital measurement of the actual energy performance[8] would automatically incorporate the complementary nature of energy efficiency and flexibility in increasing the ***carbon efficiency*** of buildings. That would be the end goal of building renovations and a pre-requisite for funding.

  There are two distinct circumstances that need to be addressed and both should be considered from a system perspective: i.e. instead of specifying individual requirements such as the fitting of solar panels, air source heat pumps, insulation standards etc. a wholistic approach to system performance should be taken – and one that incorporates electro-mobility as well.

  According to EPBD all new buildings should be nearly-zero energy buildings starting 1.01.2021. Demand side flexibility would turn the nearly-ZEB into real Net ZEB and even to positive energy buildings which would make active buildings a valuable contributor in the new energy system.

- **Skills.** One of the barriers to establishing active buildings is a shortage of digital smart building technicians to provide installation, servicing and support services. For example, installing a smart thermostat can require three technicians: a heating engineer, an electrician and an IT specialist greatly increasing the costs. Covid has provided an opportunity here in that a large number of individuals have been made redundant and require retraining. A training pipeline for Smart Building Technicians would provide the opportunity for these unfortunate people to retrain and find jobs in an exciting, growing business area.

- **New business models and smart financing.** Financing can be simplified through initiatives such as green investments and mortgages. Furthermore, some infrastructure costs can be offset: e.g. the cost of installing district heating or a gas network, which can run into many million Euros, would not be required for all-electric buildings and therefore can be put towards increased insulation, smart controllers, solar and energy storage assets[9].

  Regulations surrounding private/public partnerships for sustainable funding regimes should be reviewed and simplified. In particular, procurement competitions should be examined with a view to encouraging innovation and transferring specification risk to contractors.

  Different smart financing schemes already exist[10] and should be supported through an enabling framework. New business models, as Distributed Energy Service Company schemes (DESCo), should be promoted.

  The DESCo, ideally a social enterprise, owns and maintains the energy assets and contracts with a Utility through periodic competition the operation of

[8] See smartEn's position paper "Towards a Quantification of the Demand-side Flexibility of Buildings".

[9] Analysis conducted by geo in conjunction with house builders in 2017 demonstrated that there was not a premium for building new active homes and it is highly likely that they would become increasingly cheaper and faster to build over time and as volumes increased.

[10] *https://smarten.eu/wp-content/uploads/2018/10/Smart-Financing_final_with-date-1.pdf*

these assets. Building occupiers pay the DESCo a service charge to lease the assets and pays the Utility for their net energy (energy consumed minus flexibility payments). Utilities also pay the DESCo an annual payment to operate the franchise.

A DESCo could be set up as part of a new development or renovation scheme in order to maximise the benefits and provide an appropriate entity to receive government funding: e.g. Renovation Wave grants.

A DESCo could also provide the opportunity to implement new sustainable circular investment schemes whereby companies lease assets to consumers and have the responsibility for refurbishing them at the end of life[11] thus ensuring the Renovation Wave is the start of a circular process and not a one-off event.

12. How do flexible buildings contribute to reaching the 2050 carbon neutrality?

Being an active player in the upcoming energy system, active buildings enable the proliferation of renewable energy and improvement of the overall system energy efficiency. They involve and empower energy users and all stakeholders to contribute actively in the strive for carbon neutrality.

Buildings need to become the power house of "net-zero carbon" cities and towns, optimizing energy use and the load profile at Building/District level for local communities and providing services to grid operators and Energy/Power markets. Building integration within Grids and Microgrids will be key to manage system and market complexity through use of IoT for connected products and sensors, edge control and cloud software platforms allowing to provide advanced services. Digital will be the glue which will allow the overall system to run in an optimized way.[12]

Large scale initiatives such as offshore wind have a role to play in reaching carbon neutrality, but so do consumers, their decisions and their day-to-day actions. Flexible buildings incorporate consumers into the drive to reach carbon neutrality by delivering a holistic, integrated system that provides them with value and the means to be part of the everyday solution and not just passengers. They are the epitome of the inverted energy pyramid.

[11] See: *https://circulareconomy.europa.eu/platform/sites/default/files/circular_by_design_-_products_in_the_circular_economy.pdf*

[12] WEF, Net-Zero carbon cities *https://www.weforum.org/projects/systemic-efficiency*

This publication is possible thanks to the support of The smarter E Europe

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"Creating a new energy world" – that is the goal of The smarter E Europe, the continent's largest platform for the energy industry. In this new energy world, electricity and heat are generated decentrally from renewable energies. The share of volatile electricity continues to grow due to the new deployment of photovoltaic installations and wind power sites. How renewable energies can be better integrated into our distribution grids is therefore one of the most important questions of the energy transition, to which The smarter E Europe provides answers.

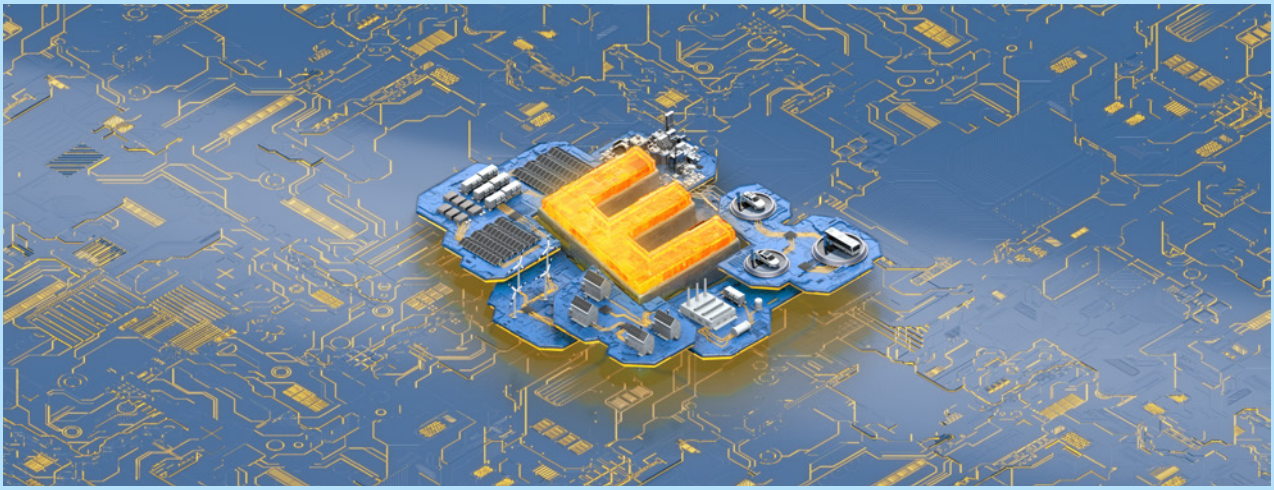
The focus is on cross-sector solutions linking electricity, heating and transportation for an intelligent and sustainable energy supply. The topics comprise all the core areas along the supply chain – from the generation, storage, distribution and usage of electricity and heat to sector coupling.

The smarter E Europe brings together four parallel exhibitions to give energy industry players from around the world a comprehensive overview of the latest innovations and trends. All events take place annually at Messe München:

- Intersolar Europe – The world's leading exhibition for the solar industry
- ees Europe – The continent's largest and most international exhibition for batteries and energy storage systems
- Power2Drive Europe – The international exhibition for charging infrastructure and e-mobility
- EM-Power Europe – The international exhibition for energy management and integrated energy solutions.

The smarter E Europe is organized by Solar Promotion GmbH and Freiburg Wirtschaft Touristik und Messe GmbH & Co. KG (FWTM).

More information: **www.TheSmarterE.de**



About smartEn - Smart Energy Europe

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Smart Energy Europe

smartEn is the European business association integrating the consumer-driven solutions of the clean energy transition. We create opportunities for every company, building and car to support an increasingly renewable energy system. Our membership consists of the following companies:

The positions expressed in this document represent the views of smartEn as an association, but not necessarily the opinion of each specific smartEn member.

For further information about smartEn, please visit **www.smarten.eu**

This paper has sought to introduce the concept of **Flexible and Active Buildings** and to outline their benefits especially given the context of the "climate emergency".

It is suggested that Active Buildings are very much an enabler for a Distributed Renewable Energy Grid that is the key to climate neutrality.

Active Buildings offer the opportunity to accelerate this clean energy transition while increasing system efficiency and the benefits to their occupants.

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