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Challenge Brief [TD2]

(EXCERPT – NOT TENDER VERSION)

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Procurers

Supporting organisations

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TABLE OF CONTENTS

Challenge Summary

Background, current situation, expected demand

It is expected that 90% of the currently existing building stock will still be in service in 2050, the year in which many cities want to reach carbon neutrality. European policies and legislation are in place to accelerate the decarbonisation in the building sector, starting out, however, from a situation where renovation is making only a moderate contribution (0.4 to 1.2% of buildings per year) and the complete replacement of the existing stock is very slow (1-1.5% per year) and not desirable. To achieve our climate goals, renovation in Europe must be accelerated, lifting many more existing buildings to an optimal efficiency level as well as maximising the self-use of renewable energy.

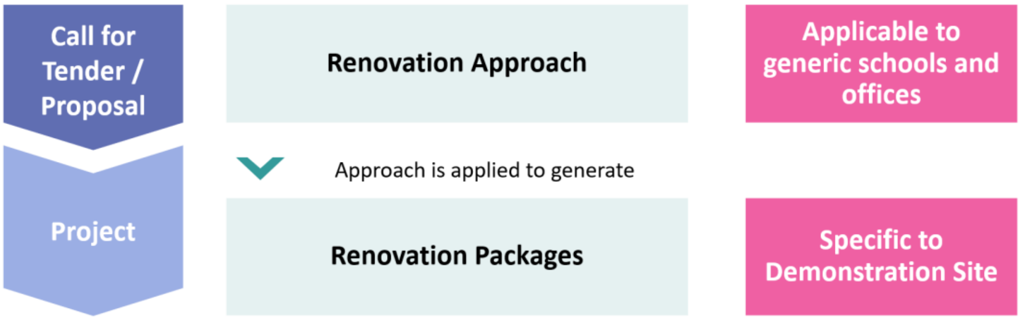
An increasing number of cities, regions and other owners of major building portfolios wish to achieve 100% renewable energy supply (RES) in their buildings. These actors are faced with barriers, such as individual constraints for adaptation for each building, provision of supply and storage, optimisation of operation and integration of solutions across technologies. Integration of the optimal selection of cutting-edge Renewable Energy technologies requires a level of expertise most owners and their planners cannot be expected to acquire. The construction sector is extremely fragmented, where more than 95% of manufacturers and professionals operate as Small and Medium-Sized Enterprises (SMEs), and most in separate national or local markets. Furthermore, investors have a natural preference for low-risk solutions and a scepticism to complexity.

Currently, there are no adequate products on the market which can deliver a 100% renewable building without undertaking invasive measures to the envelope. The Buyers Group alone operates 21,000 buildings; almost a dozen other procurers are already following the project with more expected. Their portfolios constitute ten-thousands of buildings with sufficient envelope quality to deploy the envisioned solutions. Procurers wish these buildings to be supplied by 100% local RES within a short timeframe. To make this possible, it is expected that suppliers will follow an “active approach”, optimising heavy loads in heating, ventilation, and air conditioning (HVAC) etc, adding intelligent (remote) control, energy production and storage while responding to specific usage requirements to optimise the entire building.

The common challenge

Suppliers are to design, develop, and test an innovative **Renovation Approach** capable of generating **Renovation Packages** delivering 100% renewable energy supply to any existing non-residential building with adequate envelope quality. The Renovation Approach is to be tested through generating and implementing Renovation Packages for specific non-residential buildings in Buyers Group portfolios, the **Demonstration Sites.**

Figure 1. From a generic Renovation Approach to specific Renovation Packages

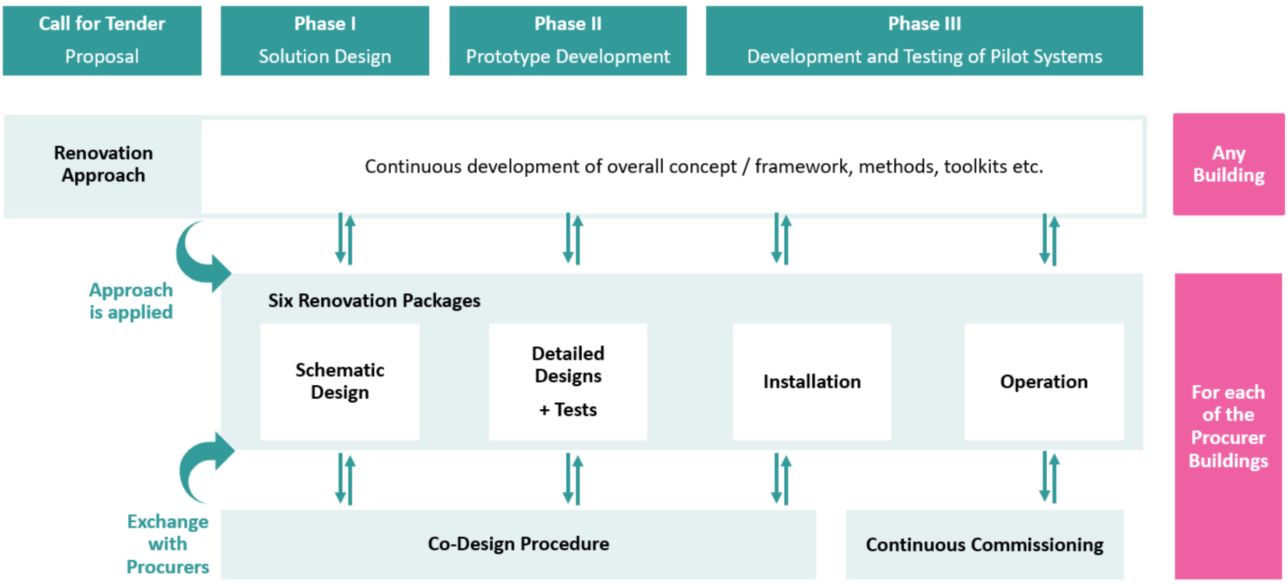


A supplier's Renovation Approach is expected to constitute a complete set of methods, technologies, services and devices integrated in a well-documented toolkit which includes at least: building assessment framework, system design and control approach, RES production, interoperable integration of legacy devices, data management and data sharing, building control, storage solutions, finance and contracting models, life-cycle cost approach, continuous commissioning, behaviour-targeting education and training of occupants and professionals.

During Phase I and Phase II**,** suppliers adapt, extend, and apply their Renovation Approach to generate Renovation Packages for six specific buildings in Buyers Group portfolios with increasing level of detail. During these two phases, suppliers will apply their Co-Design procedure[1] to facilitate information exchange, involvement, decision-making etc. Successful tenderers for Phase III will then implement the Renovation Packages in three allocated buildings, ensure performance and apply the Continuous Commissioning procedure. The initial delivery of the Renovation Package is to be turnkey-ready.

Starting with the proposal, all phases constitute R&D work on the supplier's Renovation Approach, resulting in continuous improvements based on lessons learnt during application and research.

Figure 2. Summary of core activities per phase



[1] The Co-Design procedure constitutes part of the Renovation Approach as described in the Challenge Brief.

Demonstration Sites

The Demonstration Sites are six non-residential buildings: three schools and three offices. Information on the buildings is provided in the Annex C of the Challenge Brief.

Structure of the document

The Challenge Brief is divided into sections each linked to a corresponding award sub-criterion (e.g. 1.1. to sub-criterion T1, 2.1 to sub-criterion CF1). The Tender Application Template (TD6) follows the same structure and provides detail on expected content in each section of the proposal.

Information completing the description of the Challenge (sections 1 to 3) is collected in the Annex. The following content is included:

- Annex A: procuRE building blocks: Referencing building blocks presented in pitch deck and during OMCs to sections in this document
- Annex B: procuRE Personas: Describing the user groups to be expected on-site
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The most recent version of the Pitch Deck summarising content from OMCs and including large-scale version of graphics used in Tender documents can be downloaded via the procuRE website.

1 Technical Criterion

1.1 T1 – System Integration

1.1.1 Renovation Approach to achieve 100% RES in existing buildings.

Challenge: According to the Energy Performance of Buildings Directive 2018/844/EU (EPBD), the energy performance of a building shall be determined on the calculated or the **actual annual energy demand** for meeting the different needs associated with its typical use, including the energy demand for heating and cooling to maintain the desired indoor comfort, and for providing domestic hot water. In procuRE, the electricity consumption of all appliances and systems within the building are to be included in the actual final annual energy demand.

The actual annual energy demand of a building is, to the greatest economically feasible extent, to be covered by **on-site renewable energy sources**. “On-site” refers to the building and its nearest vicinity – air, surface, ground and underground –, which, in any case, cannot exceed the building premises or attached structures. Although, for some Demonstration Sites large land surface is available, the procurers want to make sure that the solutions adopted are highly replicable at all their building stock. During the project, solution proposals for functional structures within described perimeters (e.g. courtyard) will be assessed during Co-Design on a case-by-case basis. The extent to which this goal is met is measured with indicators (section 1.2). Energy drawn from networks or otherwise delivered to the site is not an on-site energy resource.

Self-consumption is to be maximised hereby reducing interaction with energy networks. Local and temporal disparities between the production and use of renewable energy in buildings should be considered with sufficient frequency. Energy networks can be relied on to cover exceptional weather, failures etc.

The impact of operators and occupants increases in highly efficient and integrated buildings. The dimensions of **control, comfort and costs** are to be balanced in the overall approach.

1.1.2 System package design

Context: Most current energy retrofit projects do not set out from application of an adequate set of tools, but are disjointed, involving only one or a few buildings, and design starts more or less from scratch in each project. Also, many current retrofit projects result in buildings which do not operate as designed. Specific efficiency measures in the design are either not designed with the users in mind or are often not respected in construction and operation, resulting in performance not matching the original design intent. In some instances, individual systems are optimised impeding the efficiency of other systems or the building as a whole. In addition, the specification of building performance is often limited to targets for final energy or primary energy use after retrofit. In consequence, Continuous Commissioning is often not possible. Current contractors often externalise the effort of coordinating specialists to procurers who do not have the necessary resources and in-house expertise to perform these tasks efficiently and effectively.

Challenge: Suppliers are expected to offer a fully documented Renovation Approach which represents the full mastery of system specifications, independent of the size, type, and location of the building. Design procedures in the Approach are to minimise the planning efforts, concentrating and organising the necessary expertise from specialists, in particular of complex HVAC systems. The Renovation Approach must include a modular and adaptable set of technologies for energy production, storage, and management with effective and reliable components. Challenges for each of these technologies are described in the following sections.

As part of the Renovation Approach, suppliers must include comprehensive design procedures which can be as easily applied to projects covering single-buildings renovations and scalable to larger portfolio renovations anywhere in Europe. The following elements are considered the minimum necessary:

A clearly specified **design workflow** extending across the entire renovation process (design to operation) and the entire value chain. This must enable all disciplines (architects, engineers, technology providers, system integrator, energy manager…), procurers, building occupants and other stakeholders to exchange information and participate in design with clear trigger points and checks to ensure all required specialists (e.g., HVAC) and stakeholders are involved. Current reliance on procurers to fill these gaps must not be continued. The workflow is also to explain and ensure that all regulation and code requirements are met. For interaction with procurers and in support of their decision-making, the workflow has a specific “Interface to Procurers” (see Section PM1).

A **modelling and selection methodology** enabling the supplier to quickly select the best suited components for any given set of buildings, e.g. from the technologies and services mentioned in the Sections 1.1.3 to 1.1.6. This includes any components to complete the HVAC design.

The **output** of these efforts results in a Renovation Package which is specific to one building, containing clear definition of components and systems performance specifications that can easily be understood by non-technical personnel. The Renovation Packages generated must consider current building characteristics, future building use, context, regulatory framework, and climate at the location of the building. (The minimum criteria for a Renovation Package for each phase are described in TD1 section 2.1.2).

Further elements may be included by suppliers. **Procurers will welcome innovative platforms, such as BIM or others,** capable of linking stakeholders, integrating data streams, highlighting decision requirements, and providing necessary tools for modelling and verification, including to measure the energy, comfort, and health performance, as well as acting or offering building logbooks. It is considered a merit if a platform centralises and harmonises core processes from initial design to operation. This does not preclude attaching value-adding modules or micro-services from one or more third-party vendors.

1.1.3 System package monitoring and management

Context: Most current systems for monitoring and managing buildings in operation still treat each component of a system as a separate unit, with a specific function which is independent of the others. This impedes attempts at optimal operation of the whole system. This fragmented approach is often reflected in the structure of databases. To optimise behaviour and settings, operators and occupants must analyse multiple components in parallel, themselves. Monitoring and management hardware and software can offer more.

Challenge: Suppliers are challenged to include in their Renovation Approach a streamlined approach to components and processes for the operation phase of the building. Management and monitoring are to provide a “second view” on the building to ensure that design performance is achieved during operation without impeding other performance characteristics (e. g., comfort). The automated and continuous assessment of the monitoring data available needs to be the basis for energy efficiency optimisation and Continuous Commissioning (see PM1). As occupants are central to the functioning of each building – there is no smart building without informed and smart users – the monitoring systems **must have user interfaces that deliver easy-to-understand information to support behaviour change** (see T3).

Suppliers are expected to define clear and meaningful **Key Performance Indicators** (KPIs) that allow the building energy performance to be evaluated from an energy and environmental point of view at appliance, system and building levels as well as comfort and other critical or desirable functions. A mandatory set is described in T2. **Minimum and targeted performance** values are to be defined for applicable KPIs, complemented by, and linked to contractual regulations regarding costs and conditions, among other aspects, in case of divergence. These indicators should be defined in a way to demonstrate, through a Continuous Commissioning, the assessed performance also during the building operation, considering the metering and billing of energy use. These indicators give a comprehensive overview of the building, including flexibility, energy efficiency, occupant comfort, awareness and satisfaction, Smart Readiness Indicator.

For an efficient collection of measurements and a reliable calculation of the indicators, a **Monitoring System Guideline** needs to be developed where the minimum set of requirements (sensors and meters) for the monitoring and control system to be installed are defined taking precisions and tolerance fully into account. If additional sensors are deemed to provide added-value or be requested by procurers during Co-Design, these are to be documented in a subsection, including an explanation of their purpose. This Guideline will also contain the definition of all procedures linked to assess the minimum and targeted performance parameters, also feeding into Continuous Commissioning. The system must be able to recognise **manual temporary overrides** by building operators diverging from the automated management and calculate and verifiably record any additional costs resulting from such activity. Cases of divergence are to be collected, summarised, and presented as part of Continuous Commissioning procedure (PM1).

In addition to this, the monitoring system should be equipped with a remote facility and an energy management system with control and maintenance features for the building's technical systems. The **BEMS** (Building Energy Management System) should base the control not only on fixed schedules, but also on occupation, occupant behaviours and needs, system efficiency, RES availability, storage state of charge and network energy utilisation peaks and fares, among other parameters Forecasts are to cover beyond the near-term future (i.e. next hours). The system should include easy access for building operators to override system settings temporarily, record the reasons for such activity and indicate the consequence of such activity (for more detail see 1.1.6). It should be transparent to the operator when or whether the system restores automated control. The use of **smart controls** based on predictive or advanced rule-based controls would be a plus.

The system shall also create minimal and targeted information for informing and influencing occupant behaviour when deemed necessary (see T3). Upon request, it should be possible to integrate easily understandable graphics and core figures in public displays or websites linked to the building.

Similarly, as fault detection and diagnostics reduce energy consumption and discomfort due to interruption of the service, **predictive maintenance strategies** should be offered to guarantee the early detection of malfunctioning components, extend equipment lifespan, the reduction of safety, health, environmental and quality risks, as well as overall reduced costs.

1.1.4 Energy production and distribution components

Context: Public administrations and other building owners are flooded with information on RES and HVAC technologies. However, it is currently very difficult for retrofit procurers to build the necessary analytical vision of what HVAC and RES solutions they should adopt and procure for their building stock.

Challenge: suppliers are expected to improve the framework conditions for procurers to select and adopt renewable production and distribution technologies which have a **low final energy use**, **high renewable energy harvest** and **minimal life cycle impact** on the environment and the costs (LCA and LCC). Suppliers are encouraged to pre-select technologies as part of their Renovation Approach. **As a set, pre-selected technologies must** cover the procuRE climatic zones, regulatory regimes, and contexts, and be able to be safely applied to offices and schools. Most technologies should be already on the market or soon ready to be commercialised, with adaptation to the social, economic, regulatory, and environmental context of the Buyers Group Demonstration Sites, completed or at least planned.

Suppliers are expected to mostly select **proven technologies** that are cost-effective and easy-to-install, with **performance demonstrated** by standards or specifications or for selected core components, demonstrated during prototype testing in Phase II. A **minimal and coherent set** of scalable and modular pre-selected technologies capable of delivering all above will be considered a plus.

Information provided as part of the Renovation Approach for inclusion in Renovation Packages must **include core descriptions and indicators** enabling procurers to acquire and improve the knowledge base to continuously speed up and improve decisions during Co-Design and with view on multiple future renovations of the building stock using the Renovation Approach.

1.1.5 Energy storage components

Context: Energy storage will play a key role in enabling the EU to develop a low-carbon society and to ensure lasting energy flexibility and security. For a 100% RES driven building, the challenge is to have a balance between supply and demand. For this, the use of thermal and electric storage becomes key for increasing the building flexibility, shifting loads, and shaving peaks.

Challenge: suppliers are expected to improve the framework conditions for procurers to select and adopt thermal and electric storages technologies which **maximise the self-use** of the renewable energy produced on-site, they balance (**high) specific energy storage capacity**, **low specific investment cost** and **minimal life cycle impact** on the environment and the costs (LCA and LCC) depending on building constraints. Suppliers are encouraged to pre-select technologies as part of their Renovation Approach. **As a set, pre-selected technologies must** cover procuRE climatic zones, regulatory regimes and contexts and be able to be safely applied to offices and schools. Most technologies should be already on the market or soon ready to be commercialised, with adaptation to the social, economic, regulatory, and environmental context of the Buyers Group Demonstration Sites completed or at least planned.

Suppliers need to describe how they will construct safe and **reliable advanced energy storage solutions** based on **market or ready to be commercialised** individual components, their performance, constraints, and requirements (e.g., system, space). **Proven technologies** should be cost-effective and easy-to-install, with **performance** ensured by specifications or compliance with standards or shown for selected core components or integrated during prototype testing in Phase II. A **minimal and coherent set** of scalable and modular pre-selected technologies capable of delivering all above will be considered a plus.

Information provided as part of the Renovation Approach for inclusion in Renovation Packages must **include core descriptions and indicators,** in particular on **optimal storage choice and scale**, enabling procurers to acquire and improve the knowledge base to continuously speed up and improve decisions during Co-Design and with view on multiple future renovations of the building stock using the Renovation Approach.

1.1.6 Energy management components

Context: Integration of RES, energy storages and efficient components in a comfortable and healthy environment requires active control of the building technical systems, and functional information easily accessible to operators and occupants. Current Facility Management and Building Energy Management Systems (BEMS) do not cover all segments and provide insufficient information to ensure 100% RES operation.

Challenge: Suppliers are encouraged to pre-select technologies as part of their Renovation Approach. **As a set, pre-selected technologies must** cover all relevant use cases, regulatory regimes and contexts and be safely applied to offices and schools and **integrate legacy equipment** and installations. Most technologies should be already on the market or soon ready to be commercialised, with adaptation to the social, economic, regulatory, and environmental context of the Buyers Group Demonstration Sites completed or at least planned. **Proven technologies** should be cost-effective and easy-to-install, with **performance demonstrated** by standards or specifications or for selected core components or integrated during prototype testing in Phase II. A **minimal and coherent set** of scalable and modular pre-selected technologies capable of delivering all below will be considered a plus. (It will be possible to update the list of building level components during the project).

Suppliers are requested to select **cost-effective, low-impact monitoring and control systems**, devoted to gather data from sensors installed at zone and central levels, and to activate and optimise HVAC and electricity management. Solutions will need to be **highly flexible** to adapt to any HVAC system, centralised or local. **New generation**, wireless and self-powered sensors will gather information from storage, from the indoor and external environment and from the HVAC system, critical systems etc. **Actuators** or information and communications technology (ICT) solutions activate relevant legacy devices ensuring they can be monitored and controlled where necessary. All newly installed equipment (production, distribution, storage) shall either support all required functions by default or be equipped with necessary devices. On building level, information and commands are sent and collected by **a central control unit** capable to communicate with all technical systems using **stable and non-intrusive communication protocols and standards**. **State of the art IT-security strategies** are to be provided for the implemented system. It is not the aim to digitise every single aspect of the building, but digitalisation is a key aspect for achieving 100% RES operation, comfort, and a healthy environment.

A challenge lies in **integrating all data sources and making systems interoperable**. Independent of how (e.g., database formats, AI) and where (e.g., fog, edge, cloud) this is achieved, the following **functionalities** are to be provided to relevant actors in one or several systems **using harmonised**

and suitable interfaces and visualisations which are comprehensible for stakeholders with different backgrounds and skills:

- Features of usual Facility Management solutions for procures and operators
- Features of usual Building Energy Management solutions (BEMS) for procurers and operators
- Use and evaluation of indicators building, system and component performance
- Reports and insights for the Continuous Commissioning and maintenance process
- Documentation and automated entries into a building logbook (ideally linked to or a continuation of the Renovation Packages)
- Export or linking functionality to city-wide energy management solutions and/or BIM platforms
- Meaningful and timely information provided by data analysis algorithms on energy consumption, comfort, and health for occupants (to be utilised as part of T3)

Procurers welcome solutions in which all or some operator user and procurer user facing functionality is centralised in one innovative (BIM) platform. It is considered a plus if the operational processes and interfaces are a continuation of the system package design workflows using the same solutions. An additional plus would be if the building logbook and specific Renovation Packages are strongly linked.

1.2 T2 – Degree of achievement of objectives in reference / demonstration buildings

In addition to demonstrating the innovativeness and solidity of their proposals all along the design and commissioning phases by means of qualitative information provided, the suppliers are requested to assess and provide quantitative indicators showing the energy efficiency, environmental impact, and Indoor Environmental Quality (IEQ) levels achieved through the set of measures proposed during design phases and to be verified after systems commissioning.

The indicators are to be calculated for the buildings provided by the Buyers Group, namely:

- Initial proposal: Two reference buildings (school, office) in two climate zones (see **Error! Reference source not found.**)
- Phase I+II: All six Demonstration Sites. The results are part of the Renovation Package which constitute part of Call-off Offer for Phase II and III respectively (see TD1 section 2.1 for detail)
- Phase III: Documentation and Continuous Commissioning for allocated Demonstration Sites

The results of all calculations are to be entered in the Tender Application Template (TD6) accompanied by the description of the methodology and the complete time series into the Excel Annex (TD6a). Yearly values will be used to quantitatively assess overall performance accompanied by a qualitative assessment of linked hourly distributions. Multiple tenders can achieve the highest score – the focus is on a balanced and affordable approach as close as possible to 100% RES.

1.2.1 Energy Key Performance Indicators

The energy performance KPIs asses how effectively on-site RES will be harvested and exploited. In the calculation of KPIs, one year is defined as 8760 hours.

Final energy consumption (E_F)

This indicator refers to the utilisation of different energy vectors to cover the energy demand of the building independently of their origin, either local or remote (i.e., energy networks). The procurers want to make sure first that the best technologies with the least overall costs are exploited, minimising the energy needed on site.

The suppliers are requested to assess and provide final energy consumption values for each of the energy vectors (e. g. thermal, electric) utilised on site, at least on an hourly basis for the entire year. For each building accounted for in the specific design phase, the suppliers are requested to provide both whole-building energy consumption expressed in kWh/h and specific energy consumption per gross building volume (including façades volume) expressed in kWh/(m^3h). In addition to these values, suppliers are also requested to assess and provide yearly final energy consumption both in MWh/y and kWh/(m^3y). The yearly final energy consumption values are obtained integrating the hourly final energy consumption over the entire year.

Assessment: The procurers will use both yearly final energy consumption values (MWh/y and kWh/(m^3y)) for the quantitative assessment of the system performance, and the hourly distribution to verify the calculations presented.

Both dynamic simulations and semi-dynamic methods accepted by European and National norms are acceptable calculation methods. The suppliers are requested to provide indication on the calculation method and the boundary conditions adopted, together with the results obtained as part of the offer and future deliverables at the end of each design phase.

On-site renewable energy production (RE_P)

This indicator refers to the on-site production of renewable energy for the different energy vectors utilised on-site. Procurers want to make sure that the best available technologies are exploited, maximising the coverage of the energy needed on site by means of locally available RES.

“On-site” refers to the building and its nearest vicinity – air, surface, ground and underground –, which, in any case, cannot exceed the building premises or attached structures. Although, for some Demonstration Sites large land surface is available, the procurers want to make sure that the solutions adopted are highly replicable at all their building stock. During the project, solution proposals for functional structures within described perimeters (e.g., courtyard) will be assessed during Co-Design on a case-by-case basis.

The suppliers are requested to assess and provide on-site renewable energy production values for each of the energy vectors utilised on site, at least on an hourly basis for the entire year. For each building accounted for in the specific design phase, the suppliers are requested to provide both overall on-site renewable energy production expressed in kWh/h and specific renewable energy production per gross building volume (including façades volume) expressed in kWh/(m^3h). In addition to these values, suppliers are also requested to assess and provide yearly on-site renewable energy production both in MWh/y and kWh/(m^3y). The yearly on-site renewable energy production values are obtained by integrating the hourly on-site renewable energy production over the entire year.

Assessment: The procurers will use both yearly on-site renewable energy production values (MWh/y and kWh/(m^3y) for the quantitative assessment of the system performance, and the hourly distribution to verify the calculations presented.

Both dynamic simulations and semi-dynamic methods accepted by European norms are acceptable as calculation methods. The suppliers must provide descriptions of the calculation method and the adopted boundary conditions, together with the results obtained as part of the deliverables at the end of each design phase.

Renewable energy share (RE_Sh)

This indicator states the fraction of final energy consumed that is either covered by renewable energy produced on-site during the same timeframe or previously produced and stored on-site. The suppliers are requested to assess and provide renewable energy share values for each of the energy vectors utilised on site, at least on an hourly basis for the entire year.

This indicator is calculated for each energy vector "j" using the following formula:

$$RE\_Sh_{i,j} = \left.\frac{\left(E_{REU,i} + E_{EFS,i}\right)}{E_{F,i}}\right|_{j}$$

Where:

- $RE\_Sh_{i,j}$ is the renewable energy share calculated at hour "i", for each of the energy vectors "j" covered through renewable energy.
- $E_{REU,i}$ is the renewable energy produced on-site at hour "i" and used to cover a final energy use during the same hour.
- $E_{EFS,i}$ is the renewable energy previously generated and stored on-site used to cover the final energy use during hour "i".
- $E_{F,i}$ is the final energy consumption at hour "i", for each of the energy vectors "j".

In addition to hourly values, suppliers are also requested to assess and provide yearly renewable energy share values. For each energy vector "j", the yearly on-site renewable energy share value is obtained as the integral of the hourly values:

$$RE\_Sh_{Y,j} = \left.\frac{\sum_{1}^{8760}\left(E_{REU,i} + E_{EFS,i}\right)}{\sum_{1}^{8760} E_{F,i}}\right|_{j}$$

Assessment: The procurers will use both yearly renewable energy share for the quantitative assessment of the system performance and the hourly values distribution to check the temporal coverage of building energy use by means of the renewable energy produced contemporarily and/or previously produced and stored on-site.

Renewable energy production to consumption ratio (RE_PCR)

For each energy vector, this indicator refers to the fraction of renewable energy produced on-site that is contemporaneously consumed in the building, hence reflecting the **temporal concurrency of renewable energy production and final energy consumption**. For each of the energy vectors used on site and on an hourly basis, the values should be calculated as the ratio of renewable energy produced on site and the final energy consumption in the same timeframe. The fraction can be higher than 1 during some periods due to overproduction.

The renewable energy production to consumption ratio shall be calculated as:

$$RE\_PCR_{i,j} = \left.\frac{E_{REP,i}}{E_{F,i}}\right|_{j}$$

Where:

- $RE\_PCR_{i,j}$ is the renewable energy production to consumption ratio calculated at hour “i", for each of the energy vectors “j” covered through renewable energy.
- $E_{REP,i}$ is the total renewable energy produced on site at hour “i”, for each of the energy vectors “j” covered through renewable energy.
- $E_{F,i}$ is the final energy consumption at hour “i” for each of the energy vectors “j”.

In addition to hourly values, the suppliers are requested to assess and provide also yearly renewable energy production to consumption ratio. For each energy vector “j”, yearly renewable energy production to consumption ratio shall be calculated as:

$$RE\_PCR_{Y,j} = \left.\frac{\sum_{1}^{8760} E_{REP,i}}{\sum_{1}^{8760} E_{F,i}}\right|_{j}$$

Assessment: The procurers will use both the yearly renewable energy production to consumption ratio for the quantitative assessment of the system performance, and the hourly values distribution to check whether an attempt has been placed on continuously balancing local renewable energy production and the building’s final energy use. As some buildings like schools are not in use during relevant periods of the day and of the year, a better matching reduces the need for storage capacity installed optimising the utilisation of renewable energy produced on-site.

On-site renewable energy utilisation (RE_UT)

This indicator refers to the renewable energy that is produced and used or stored on site, hence without being exported and then re-imported to the building premises. Export/Import of on-site produced renewable energy has a cost for the community, both environmental and economic, due to losses, infrastructures to be set up, etc. The procurers want to make sure that the burden onto the community is minimised technically and economically as much as possible. The suppliers are requested to assess and provide on-site renewable energy utilisation values for each of the energy vectors utilised on site, at least on an hourly basis. The values should be calculated as the ratio of renewable energy produced and used or stored on-site along the considered timeframe, and the renewable energy produced in the same timeframe. The on-site renewable energy utilisation shall be calculated as:

$$RE\_UT_{i,j} = \left.\frac{(E_{REU,i} + E_{ETS,i})}{E_{REP,i}}\right|_{j}$$

Where:

- $RE\_UT_{i,j}$ is the renewable energy utilisation calculated at hour “i", for each of the energy vectors “j” covered through renewable energy.
- $E_{REU,i}$ is the renewable energy produced at hour “i” and used to cover a final energy use during the same hour.
- $E_{ETS,i}$ is the renewable energy produced and stored on-site at hour “i”.
- $E_{REP,i}$ is the total renewable energy produced on-site at hour “i”, for each of the energy vectors “j”.

In addition to the hourly values, suppliers are required to assess and provide yearly on-site renewable energy utilisation values. For each energy vector “j”, the yearly on-site renewable energy utilisation value shall be calculated as:

$$RE\_UT_{Y,j} = \left.\frac{\sum_{1}^{8760}\left(E_{REU,i} + E_{ETS,i}\right)}{\sum_{1}^{8760} E_{REP,i}}\right|_{j}$$

Assessment: The procurers will use both yearly on-site renewable energy utilisation values for the quantitative assessment of the system performance, and the hourly values distribution to check whether continuous balancing of local renewable energy production and utilisation has been achieved.

1.2.2 IEQ Key Performance Indicators

Retrofitting of buildings should not have only an energy dimension, but also consider users, whose health and welfare are of utmost relevance for the Procurers. Accordingly, IEQ should be considered as a key element of the Suppliers' proposals.

Starting in Phase I, more or less stringent IEQ requirements for each Demonstration Sites might be negotiated with the procurers through the Co-Design procedure. Better comfort conditions offered, e.g., accounting for improved humidity control compared to the minimum normative requirements, will be a merit.

Indoor air temperature (IEQ_T)

Suppliers are requested to respect minimum requirements in terms of thermo-hygrometric air conditions as per European and national normative. During occupancy hours, the temperature should never fall below 21°C nor exceed 25°C.

Assessment: The procurers will use the total number of hours during which the indoor air temperature level is being exceeded for the quantitative assessment of the system performance, and the hourly distribution to check how continuous achieved conditions are.

Indoor air quality (IEQ_AQ)

Suppliers are requested to assure that suitable air quality conditions are delivered to the building users during occupancy hours, according to the best practices and technologies available today and in line with the European and national regulatory requirements.

The suppliers are requested to assess and provide air quality conditions values at least in terms of ppm of CO_2 and provide the number of hours above the threshold of 1000 ppm CO_2. The suppliers are requested to provide descriptions of the calculation method and the adopted boundary conditions, together with the results obtained as part of the deliverables at the end of each design phase.

Assessment: The procurers will use the average CO_2 value and the total number of hours during which CO_2-threshold is being exceeded for the quantitative assessment of the system performance, and the hourly distribution to check how continuous achieved conditions are.

----RELEVANT ONLY FROM PHASE I

Lighting conditions (IEQ_LC)

Suppliers are requested to assure that comfortable lighting conditions are delivered to the building users during occupancy hours, according to the best practices and technologies available today and the European and national regulatory requirements.

The suppliers are requested to assess and provide illuminance values in lux (cd/m^2), UGR (Unified Glare Index) and CRI (Colour Rendering Index) at representative working/training places. Both dynamic simulations and semi-dynamic methods, accounting for coupled artificial and natural lighting effects and for automated controls and accepted by European norms are acceptable calculation methods. The suppliers are requested to provide indication on the calculation method and the boundary conditions adopted, together with the results obtained as part of the deliverables at the end of each design phase.

1.2.3 Environmental Key Performance Indicators

CO_2 emissions during operation (E_CO2)

The performance indicator relates on the carbon dioxide (CO_2) emissions of the proposed retrofit solution during building operation; the emissions values are to be computed based on the net final energy drawn from energy networks. For each energy vector imported on site, the suppliers are requested to use CO_2 emission factors derived from the most recent Covenant of Mayors (CoM) Emission Factors[2]. During the proposal, the most recent default values are to be used. During the project, national emission values reported in the CoM resource for each Demonstration Site are to be used.

Assessment: The procurers will use the total from all vectors for the quantitative assessment of the system performance.

----RELEVANT ONLY FROM PHASE II

Global warming potential over the system Life Cycle (E_GWP)

Starting from Phase II of the design process, the Suppliers will be requested to also assess global warming potential (GWP, measured in kg CO2-Equivalent) of the system over its Life duration, from “cradle to grave”. GWP assessment will need to account for components’ manufacturing, transportation on site and disposal at life end, as well as for the installation process. These data are to be determined based on product-specific environmental product declarations (EPDs). If specific environmental declaration datasets are unavailable, recognised generic datasets[3] are to be used. Datasets need to comply with DIN EN 15804.

Waste management (E_W)

Starting from Phase II of the design process, the Suppliers will be requested to define and implement a plan for the management and possibly recycling of the waste materials produced during installation phases. Suppliers will need to provide information on the mass and type of waste generated together with the amount of such mass that will be recycled.

1.2.4 Suggestions of further performance indicators

Suppliers may suggest further performance indicators to be documented and recorded in Renovation Packages, during lab-tests and/or operation across all sites.

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[2] Joint Research Centre Data Catalogue - CoM Default Emission Factors - European Commission (europa.eu)

[3] For instance https://www.oekobaudat.de/en

1.3 T3 – Training & Education of professionals and users

Context: **Operators** – including energy professionally employed by the municipality as well as third-party contractors needed for repairs etc. – are faced with increasing complexity of building operation with many contractors having little to no experience with digital solutions. Whilst some issues are structural such as the lack of vocational education and training (VET), the suppliers of solutions also often consider training to be the responsibility of the customers.

Occupants' behaviour and habits influence the performance of a building, and more so in highly efficient and automated buildings. There is a significant gap between what is known to work to engage individuals in behaviour change and what is currently being applied in practice in the energy efficiency domain. Projects for public buildings tend to address the collective rather than the individual which leads to the typical problems surrounding the use of public resources and personal involvement.

Challenge: Suppliers are expected to deploy innovative training and education methods and materials. Learning should be **blended in daily use**, in particular for ICT and software. The flow between usage and learning should be seamless, not creating a burden or a substantial effort to increase knowledge.

Training of operators

ICT-systems should be intuitive and instructive with learning incorporated using recent best practice, especially when new features are deployed. Suppliers will describe how assistance is provided transparently across systems and technologies. A single touch point would be considered a plus. Shared viewing solutions and / or secure remote desktops are expected.

Suppliers provide a **learning platform** including a curated (self-)training programme for municipality staff including operators and if helpful procurers. The programme should be adapted to the requirements of the specific building based on the Renovation Package and be responsive to pre-existing user knowledge. Procurers have no preference as to the formats used as part of the programme.

Documentation of systems and hardware should clearly describe responsibilities in operation, regarding automation and any manual tasks needed on-site. Suppliers are expected to provide easily understandable materials and / or demonstrate innovative and interactive materials, (e.g. embedding existing smartphones and tablets for augmented realities) accessible for all professional levels including installers. In Phase III, instructions are to be provided in the official languages, and other native languages spoken by installers, where applicable.

Regarding **third-party contractors**, suppliers are to outline what knowledge will be required for reliable and timely operation and maintenance activities and how this is ensured. Solutions could include training and accrediting installers.

If full-service providers are to minimise dependency on inexperienced third-party installers in the long-term reducing the need for above, this should be referenced here, and quality and feasibility of the approach clearly described as part of PM2/3.

Education of occupants

The supplier's approach to education will ensure the technical solution described above is feasible with users and will help to avoid the traditional operator-occupant conflict regarding comfort and requested, actual and perceived control.

Suppliers are expected to develop a **solution that makes occupants aware of their behaviour's impact** and, in combination with carefully tailored training measures, makes them feel responsible to reflect on their behaviour if it is energetically relevant or if health could be improved without increasing consumption. Suppliers will offer information and feedback to occupants which suggests specific action including information on how the building's consumption levels would change as well as the impact (e.g. climate impact, monetary terms) of not acting documented to be most successful in the given context. The entire system will be designed to ensure that all the building occupants (workers, teacher, pupils…) can easily understand and interact with the building without any need for extensive training.

Children and other curios occupants are to be considered with creative features. Both, on-the-spot learning elements for energy usage/savings, data or technology used in the building (e.g., via QR-Codes, printable information) as well as serious games or gamification features (e.g. treasure hunts, orienteering, simulations) are to be provided. Games are accessible to teachers and can be used during on an average school hour and, where possible without additional effort, incorporate live data. Long-term competitions such as leading boards or topical challenges are only to be introduced if they are clearly incorporated into the overall education approach.

Suppliers are invited to, where possible, utilise and reference personas described in Annex B: procuRE Personas in their descriptions of services.

1.4 T4 – Innovativeness compared to market state-of-art

Context: It is the procuRE Buyers Group's position that for many applications a sufficient range of technologies and components exists to renovate the Demonstration Sites to a 100% RES-level. The challenge does not lie in achieving a certain amount of energy savings or renewable energy production and storage, but to develop a complete and innovative Renovation Approach that addresses the requirements of the building owners to retrofit their building stock.

Challenge: Suppliers are to prove how their proposed Renovation Approach goes beyond the current state-of-the-art in renovation, hereby showing that it is innovative; and which elements of it are to be further developed or improved in the R&D services to be delivered.

2 Commercial Feasibility Criterion

2.1 CF1 – Investment and energy service contracting and financing models / Costs

Context: Multiple barriers for public administrations exist to progress as expected in the Renovation Wave and to achieve 2050 targets. The most obvious are design and investments costs which limit the number of renovations which can be financed per year. Although the market is offering novel contracts to large private projects, these concepts remain often inaccessible for public procurers aiming to retrofit individual buildings (unattractive investment) and / or aiming for holistic and complex solutions as envisaged (perception of risk) and /or inadequate information performance on the energy efficiency measures is provided (both). As presented in the technical section, many procurers may not have the capacity or organisational capability to act on this gap.

Since the issues arise from a lack of structured information, the Renovation Approach is to provide more clarity on the overall framework conditions to be deployed and in a second step calculate total cost of ownership for individual Renovation Packages, digressing from the current practice and preference of most procurers.

Challenge: Suppliers are expected to develop and deliver an **innovative approach to the financing of energy renovation** and following O&M including (i) technical and financial due diligence (ii) financial risk quantification; (iii) identification of eligible public funding; (iv) access to platforms enabling matching of investment demand and offers.

Leveraging available funding opportunities (public and/or private), suppliers must describe a **financing scheme** for **single building retrofits and** are expected to also offer a separate or complementary **portfolio level scheme.** These schemes leverage investment capital for public procurers able to cluster building retrofit actions to increase the scale of investment to make it more attractive to investors and reduce risk.

Independent of the volume of the retrofit, the approach should clearly describe and quantify the investment (capex), energy services (opex) and contracting models as well as their costs and conditions to be used at least in the countries represented by the Buyers Group. **Procurers do not state a requirement or specific preference for any contracting model**.

The approach should achieve the following to the largest extent possible:

- **Enable a larger number of renovations per year** by flattening or reducing the cost curve
- Increase **confidence on benefits and reduce connected risks** for procurers and investors by creating transparency about all aspects of models/funding and existing experience with it
- Integrate **innovative financing methods** with funding opportunities to leverage a wider range of funds, including existing and upcoming (inter)national funding schemes for specific Renovation Packages
- Produce swiftly preliminary and detailed **economic plans** including
    - structure of contracts for energy and facility management services,
    - clarity on ownerships and a clear and concise calculation of all costs for procurers at least on yearly basis (e.g. annual fees, design, investment, operation, and maintenance costs), including:
        - the use of incentives,

        - contracting schemes and
        - financing models
    - as well as uncomplicated rule set for discretions from performance benchmark / KPIs induced by either party
- Where relevant consider the EU taxonomy for sustainable activities.

It would be considered a plus if future contracts would actively promote the social dimension of any action, creating new business opportunities and generating highly skilled jobs at local level as part of the planning, installing, and managing of the renovation solutions they will deliver.

2.2 CF2 – Commercialisation Plan

Context: The construction market is highly fragmented and often siloed across countries. The large number of players increases the efforts and the perceived risks by procurers. The involvement of many actors also often leads to delays. At the same time, Europe is expected to start the Renovation Wave with many actors requiring a larger number of renovations to a higher energetic level.

Challenge: suppliers are expected to describe the envisaged methodology and business plan to bring their Renovation Approach to the market, including:

- Organisational structure facing procurers (e.g., one-stop-shops)
- Applicability of Renovation Approach to other building types
- Access to market in countries represented by the Buyers Group
- Access to market across the EU and other countries
- Measures on certification and standardisation

3 Project Management Criterion

3.1 PM1 – Interface to procurers

Context: Currently, operators of building cannot procure a full Renovation Package or the necessary service from one provider and are therefore forced to buy-in and sometimes coordinate services and works increasing the number of possible points of failure. This situation is overburdening the customer in terms of resources and the expertise required to be kept in-house.

Challenge: suppliers are expected to remove procurers from the inner workflow of system package design to the largest extent possible whilst enabling procures whenever required to make rapid and informed decisions on the elements of the Renovation Package as presented. The challenge lies in finding the best balance between information and involvement. Ideally, the same interface is also during operation.

3.1.1 Toolkit

A solution is required to manage information collection and exchange, file access and documentation with procurers (and possibly all specialists or other external stakeholders). It provides access to a recent version of the Renovation Package as well as the history. The solution must require as little training as possible. The solution could be integrated into a BIM solution or utilise existing cloud-based solutions. The solution must observe necessary certifications and data safety and protection regulation.

Suppliers are free in suggesting how, where and when information is exchanged, or decisions are triggered. These procedures are to be described for design, planning and implementation (Co-Design Procedure) as well as operation & maintenance (Continuous Commissioning) clearly linking the description to the related supplier workflows.

3.1.2 Co-Design Procedure

The initial commissioning of a renovation is complex and might require input or decisions from procurers at various points in time. Depending on the scope of the renovation, a wide range of requirements need to be collected from varying roles at the procuring organisation (individuals with decision making power or controlling the budget), operators of the building (energy or facility mangers) and occupants to the extent possible. Additionally, these inputs need to be aligned with a wide range of regulations and building codes (see **Error! Reference source not found.**).

An efficient, effective, and reliable Co-Design Procedure includes at least the following:

- One-face to the customer approach
- Clarity on responsibilities and timing
- A process for information requests from supplier to procurer ensuring minimal friction and effort
- Regular exchange meetings in which suppliers inform the procurers about the most recent version of the Renovation Package and state of work
- Decision making tools based on relevant information and the documentation in Renovation Packages
- Transparency on the most recent version and recent changes in the Renovation Package aiding quick orientation by procures

Suppliers should take the following key principles into consideration:

- It is inclusive as it **includes representatives from all stakeholder groups involved** in the future service delivery and utilises feedback, advice and decisions service from procurers, operators, possibly occupants and other professionals in the field,
- It is **actor-centred** as each step consists of the actions of individual or collective entities (persons or organisations) and is described, enacted, and analysed in that perspective,
- It is **iterative** in its overall approach and in each step, as changes and adaptations are a natural part of the process,
- It is **evaluative** since each step, its alignment with the previous ones (summative perspective) and its anticipated impacts on following steps (formative perspective) are evaluated empirically,
- It is **outcome-focused** as it is designed to achieve outcomes, where the potential solutions can be rapidly tested, effectiveness measured, and the scaling of these solutions can be developed with stakeholders and in context.

3.1.3 Continuous Commissioning

Continuous Commissioning should be a highly standardised process requiring little effort on the procurer side. Among others, clear timelines, trigger points for actions, report formats, meeting agendas ensure that targeted performance and costs are achieved and any mitigation measures necessary do not lead to sudden cost hikes. Any preparation of a Continuous Commissioning process considers at least:

- Performance against KPIs
- Divergence from performance targets including reasons and costs incurred from operator activity
- Operating and maintenance costs
- Impact of occupant behaviour, unused potentials, and the utilisation of education
- Predictive maintenance
- Recommendations for mitigation and / or optimisation measures

Furthermore, the process should include transparent and open **lessons to be learnt for future renovation measures** in all or specific building types / scenarios to continuously improve the Renovation Approach and as a result future Renovation Packages, anticipating the close relationship supplier and procurer would have when more renovations are triggered.

Wherever possible, Continuous Commissioning should be an extension of the Co-Design Procedure with clear documentation in monitoring and management systems and/ or the logbook.

3.2 PM2 – Quality and completeness of the work-plan as well as detail of task and result descriptions

Challenge: suppliers are expected to remove inefficiencies typically encountered during design, retrofit and operation / continuous commissioning and make transparent how a Renovation Package is drafted, (co-)designed and finalised as well as how the renovation procedure would take place and what provisions exist during operation. This requires a comprehensive workplan, to include work packages, tasks, and responsibilities. The workplan needs to be drawn out for all PCP phases.

3.3 PM3 – Feasibility of plan and resources to meet the objectives

Challenge: procuRE requires suppliers to integrate many systems (legacy and new). Suppliers are to take over the responsibility for interoperability and system-wide optimisation. The process of applying (and further developing) the Renovation Approach to any given building will have to be complete and smooth. The supplier is asked to describe the choice of any subcontractors for the tender and / or during the project lifetime, at the very beginning of Phase III at the latest.

Overall, the details on the resources needed to achieve the work-plan have to be provided for each organisation involved in the tender. Other required resources, such as those for travel and licenses, need to also be quantified and provided.

The operational capacity of the suppliers aligned with the plan and resources need to be convincing and address all phases (for detail in each Phase see TD1 section 2.1). The tender plan should have a convincing operational capacity, e.g., reflected already in the consortium composition, or by having a plan and reserved budget for involving local (sub)contractors while complying with the limit on use of subcontracting.

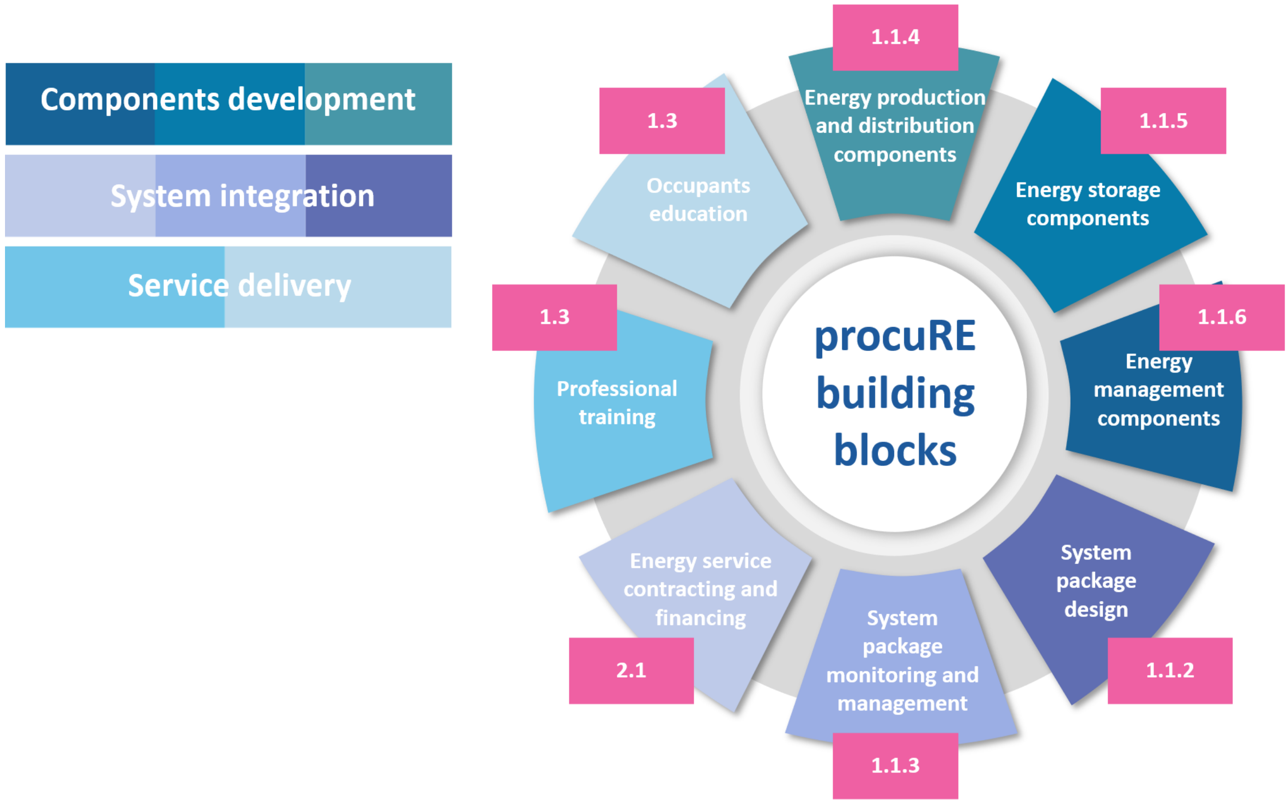
The supplier shall describe how it will provide timely operational and maintenance services after the end of the project. If the approach relies on local partners or (sub)contractors not part of the initial consortium, the supplier shall describe how it will attract and enable these during Phase I and II for the following phases and / or the duration after the project.

ANNEX

The following content is complementary.

4 Annex A: procuRE building blocks

The common challenge was presented as a set of building blocks during open market consultation and in the pitch deck. The content of these slides has been incorporated in the Challenge Brief. The following graphic refers to relevant sections in this document.



5 Annex B: procuRE Personas

A persona identifies user profiles with different personal and socio-economic background and varying needs. It also considers the potential benefits that can be derived from digital resources for the person and associated stakeholders. These personas, once finished, will be made freely available with the hope that they will make a positive impact on the development and implementation of information and technology products.

Personas will be developed throughout the project and used in future guidance. A preliminary list of clearly identifiable personas was developed.

Table 1: Preliminary list of personas for procuRE.

Persona ID	Description
Adult Occupant - Champion	Adult occupant that is in continuous interaction with the procuRE system, e.g., someone working in the building, and is driven about sustainability issues. They are interested in taking an active role to ensure the efficient operation of the building and contribute to environmental protection.
Adult Occupant - Regular	Adult occupant that is in continuous interaction with the procuRE system, e.g., someone working in the building, and is not particularly interested in sustainability and energy issues or interacting with the procuRE system. They may require more motivation and information to be involved in the operation of the building.
Child Occupant	Child occupant that is in continuous interaction with the procuRE system, e.g., a student in a school. They have limited possibilities to interact with the system, but their behaviours are important to ensure good indoor comfort and energy performance.
Operator	The person who has the main responsibility for the operation of the building. Energy manager, janitor, facility managers.
Procurer	The person who works at the procuring organisation and has decision making power about the procuRE project.

Based on this, and information available in the literature, five personas have been developed, the Procurer “Mateo”, the Operator “Zeynep”, the Champion Adult Occupant “Filipe”, the Regular Adult Occupant “Maya” and the Child Occupant “Sofia”. Each have a representative age, occupation, education/previous knowledge, and frustrations related to procuRE.

*The description of personas, in particular motivation and frustrations, are **generalised examples** and descriptions therein should be considered as such. The Challenge Brief in sections 1-3 prevails.*

	Procurer	Operator	Occupant 'Champion'	Occupant 'Regular'	Occupant 'Child'
Personal Information	 Mateo, 58	 Zeynep, 47	 Filipe, 35	 Maya, 40	 Sofia, 10
Occupation	Head of Public Procurement	Energy Manager	Teacher	Office Worker	Pupil
Education/ Previous Knowledge	Mateo holds an advanced degree in Finance and has decades of experience in procurement. He is very familiar with the local legal frame work.	Zeynep holds a degree in engineering and is highly technologically savvy. She is very familiar with the current state of the building and the HVAC and energy systems in place. She is very passionate about sustainability and energy savings and listens to podcasts to stay up to date.	Filipe is well educated; he holds a graduate degree and likes to keep up to date by reading relevant articles online; he doesn't read specialist journals. He has a good basic understanding of renewable energy and the science behind it but doesn't know about the engineering or real world challenges. However, Filipe is interested in learning more	Maya holds a degree in Business and Administration. While sometimes she hears about renewable energy topics from friends or in the news, she does not actively search them out. Maya does not have a particular interest in renewable energy.	Sofia has learned a little about energy at school but has only a very basic knowledge. She does not know much about renewable energy types or retrofits.
Motivations	Mateo is interested in renewable energy but has no overview of technologies and contractual models inducing insecurity to make decisions. He sees any retrofit as an extension of life of the building and is concerned with the security and durability of work	As Zeynep is interested in sustainability, she is excited about making the building as efficient as possible. Zeynep sees the maintenance cost as a bigger consideration than the initial investment cost. She would like a system which uses sensors to pre-emptively flag	For Filipe this project presents a valuable learning experience. He would like to use this opportunity to connect sustainability to students' everyday lives and impact their behaviour. By updating students during the course of the building works he hopes to build a personal connection to the project and its	Maya's primary concern is the comfort of her work environment. While she supports the use of renewable energies, s he does not want it to interfere with her productivity. This year she is particularly concerned about ventilation and its impact on her health	Sofia is excited about the project coming to her school and is keen to learn more about renewable energy. She wants to have positive impact on the planet. Moreover, she would like to see the new equipment which has been installed in the school herself and

	done. All systems must be robust against user error and able to operate in case of failure. Losing use of buildings for prolonged periods is not acceptable. Any new systems must be future proof. Work should be completed on time and to an agreed standard.	problems and explain when and where they occurred, thus simplifying her work.	outcomes. He would like to see an intelligent system which can display current data on energy used/ stored as well as individual breakdowns by classroom. He hopes he can use this to educate students on the effects of their own actions and how best to reduce energy consumption.	because of viruses. She would like an improved air quality and hopes that plants can be incorporated to improve the work environment. Maya is excited whenever offi ce amenities are upgraded. She is hoping the office will look modern and sleek.	learn about its functions. She likes sharing what she learned at school with her family members.
Frustrations	Due to previous experiences, Mateo lacks trust in suppliers and is stressed when he must re-convene with financing partners du e to poor initial detail. He is worried about being saddled with experimental technology with no long-term contact or after-care services provided by suppliers. As some public buildings are heritage listed, he is also worried about the limitations or increased costs this causes. He is worried about wasting time and money developing an oversized system just to cover rare peaks. Mateo does not want the building function to be impeded by the new design.	Currently, the heating system has only one control which is accessible to all occupants. This means anyone can directly turn off the system for the whole building if their office is too hot. When thinking of the retrofit her main concerns are her ability to maintain the site, for example how much time needs to be spent on maintenance and the availability of replacement parts and experience d or specialised staff.	Filipe is frustrated by the difficulties caused by the school's outdated HVAC system. In the summer cooling is inefficient causing an environment where students are uncomfortable and disrupting their learning. Because the system cannot run independently in different sectors, some classrooms are either too hot or too cold.	Maya is frustrated that the current HVAC system is too complicated and only the operator knows how to control the thermostat. She is worried about being disturbed by lengthy restorations to the building. Maya does not want to sacrifice office floor space for a renovation.	During summer, the large windows make it difficult to read the whiteboard when the sun is bright. Due to the inefficient HVAC system classrooms take a long time to heat up or cool down disrupting Sofia's productivity and ruining some sensitive activities (e.g. baking or science experiments).