

GUIDANCE DOCUMENT ON PROCURING SUSTAINABLE BUILDINGS AND CONSTRUCTION



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¹ The One Planet Network is the network of the 10 Year Framework of Programmes on Sustainable Consumption and Production (www.oneplanetnetwork.org)

² Ibid.

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1. Introduction to the Guide

Procurement officers have a tremendous opportunity to greatly affect change and contribute to the sustainable development of built environments. This guide intends to provide a practical overview of the options and methods for procuring sustainable buildings and construction in developing countries and emerging economies. Primarily aimed at procurement officers, the main focus is on public procurement at a building scale. However, these concepts are applicable to institutional and private sector actors as well. This guide covers a number of procurement methods and processes, including newer methods of integrated project delivery (IPD) and public-private procurement. As the case studies indicate, these procurement methods show great promise for delivering sustainable buildings.

This guide is focused on procurement at the building-scale, and therefore does not include specific guidance beyond the building system, for example the interface at the neighbourhood scale (e.g. distributed energy systems) and infrastructure including public transport, cycling, and pedestrian access. However, many of these same procurement examples can be applied at a different scale, such as zoning, neighbourhoods, or infrastructure.

The guide assumes the reader has a basic knowledge of the building and construction process. Further, it is not intended as an introduction to the concepts of “green” or “sustainable” building design. Instead, this guide uses short highlights of innovative and sustainable construction procurement across different sections to illustrate and inspire a transition toward more sustainable procurement. The report is structured as follows:

- Section 2 gives a general overview of sustainable public procurement, kindly provided by UN Environment who is leading the One Planet Network³ Sustainable Public Procurement Programme.
- Section 3 presents sustainable building and construction concepts and highlights the sustainability aspects.
- Section 4 explains procurement strategies and project delivery systems, target setting, working with markets, pricing, team selection and client responsibilities.
- Section 5 describes building certification and rating tools, and discusses indicators and their relationship with sustainable procurement, as well as legal frameworks.
- Section 6 deals with performance measurement and tracking.
- Section 7 explains strategies for calls for tenders.
- Section 8 contains examples of real cases, sharing lessons learned from procurement projects containing clear sustainable buildings and construction components.
- Section 9 summarises the recommendations.

³The One Planet network (www.oneplanetnetwork.org) has formed to implement the 10YFP, which supports the global shift to SCP and the achievement of SDG 12. It is a multi-stakeholder partnership for sustainable development, generating collective impact through its six programmes: Public Procurement, Buildings and Construction, Tourism, Food Systems, Consumer Information, and Lifestyles and Education

2. Sustainable Public Procurement⁴

Sustainable Public Procurement (SPP) contributes to sustainable development. Through SPP, governments can lead by example and deliver on key policy objectives. SPP is a means for governments to reduce greenhouse gas emissions, improve resource efficiency, and support recycling. Positive social results can include poverty reduction, job creation, improved work places, improved equity, and respect for core labour standards. From an economic perspective, SPP can generate income, reduce costs, and support the transfer of skills and technology.

The UK Government provided a guide for sustainable procurement for construction projects for the London 2012 Olympic and Paralympic Games. It notes that *“sustainable procurement helps ensure value for money and lower operational costs whilst protecting the environment and bringing us wider societal benefits.”* (DEFRA 2012)

The guide defined eight principles for procurement as follows:

1. Seek a clear and public commitment to sustainability at the highest level of the organisation
2. Prepare thoroughly: early consideration of sustainability
3. Set specific, clear, and challenging sustainability targets from the outset
4. Be an intelligent client: get the right people on board, define the project, and set the budget
5. Embed sustainability objectives throughout the team and supply chain
6. Identify and use low-impact, responsibly sourced products and materials, and ensure good supply chain management
7. Create a structure that supports a collaborative approach whilst maintaining an environment of challenge
8. Organise procurement so that services can be shared.

(DEFRA 2012)

Public procurement wields enormous purchasing power, accounting for an average of 12% of gross domestic product (GDP) in OECD countries, and up to 30% of GDP in many developing countries (UNEP n.d.). Leveraging this purchasing power by buying more sustainable goods, services and works can help drive markets in the direction of sustainability, reduce the negative impacts of an organisation, and produce positive benefits for the environment and society. After two decades of progress, SPP is now regarded by many organisations as an important instrument in helping to achieve the Sustainable Development Goals⁶.

DEFINING SUSTAINABLE PUBLIC PROCUREMENT

Sustainable public procurement (SPP) is a *“process whereby public organisations meet their needs for goods, services, works and utilities in a way that achieves value for money on a whole life-cycle basis in terms of generating benefits not only to the organisation, but also to society and the economy, whilst significantly reducing negative impacts on the environment.”*⁵

In some regions, SPP is also known as green purchasing, environmentally preferable purchasing, or socially responsible procurement. In this report, we use “SPP” and “SP” as an umbrella term to cover these activities, recognising that there are important regional and organisational nuances to how such terms are defined, and that not all organisations that undertake sustainable procurement are governments.

“Public procurement” is used in this report as an umbrella term to describe procurement, purchasing, and acquisition made by governmental organisations. “Procurement” includes any professionally managed purchasing or procurement activities.

⁴ Section extracted from the 2017 Global SPP review, UN Environment, 2017

⁵ Definition adopted by the Task Force on Sustainable Public Procurement led by Switzerland and adopted in the context of the Marrakech Process on Sustainable Production and consumption led by UN Environment and UN DESA.

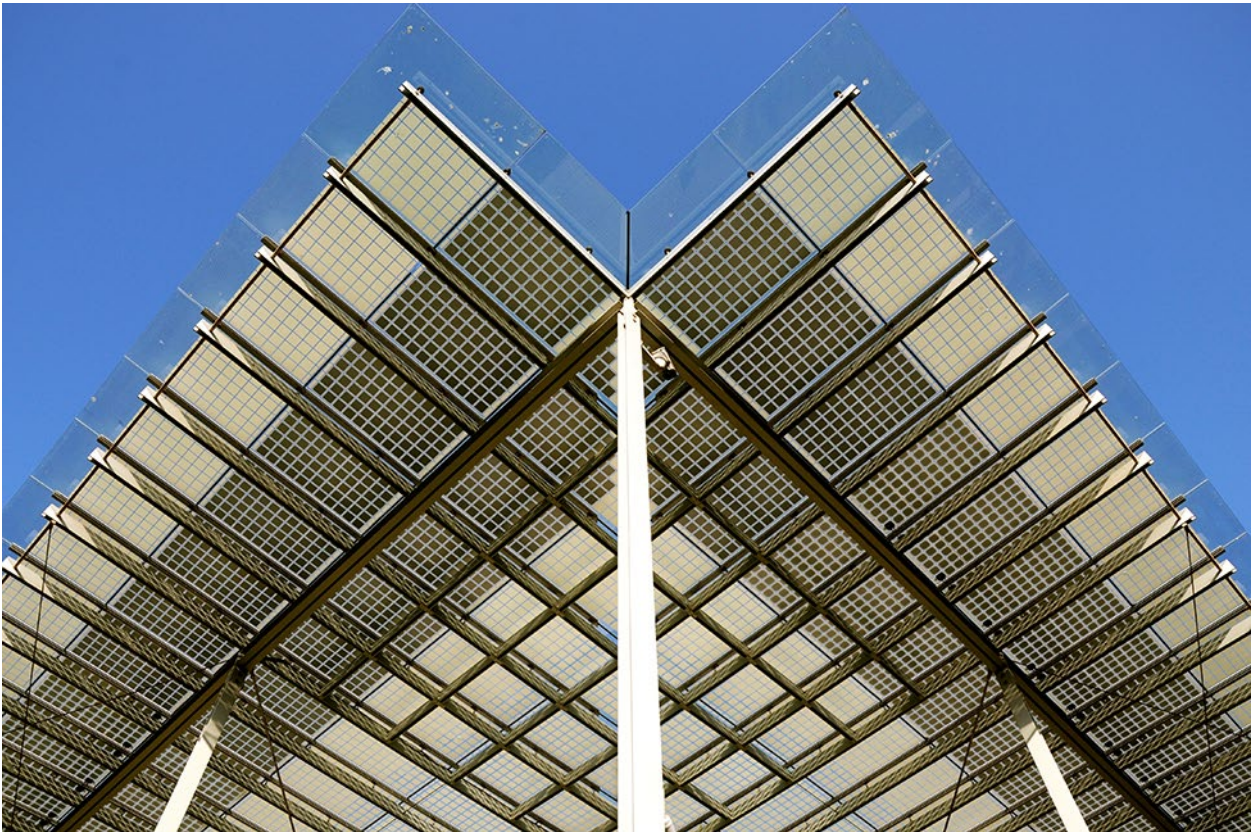
⁶ The Sustainable Development Goals are a “comprehensive, far-reaching, and people-centered set of universal and transformative goals and targets” that aim to end poverty, hunger, and inequality, take action on climate change and the environment, improve access to health and education, build strong institutions and partnerships, and more. Over 150 world leaders adopted the SGDs in September 2015 and committed to implementing them by 2030. United Nations. 2015. “Transforming our world: the 2030 Agenda for Sustainable Development” United Nations Sustainable Development Knowledge Platform. Retrieved from: <https://sustainabledevelopment.un.org/topics/sustainabledevelopmentgoals>

Sustainable procurement (SP) is not only practiced by public authorities. Many different organisations in the private and non-profit sectors are also leveraging procurement processes to focus on sustainability issues. In so doing, they are seeking to reduce their organisations' risks, to encourage sustainability in their value chain as part of their social responsibility and citizenship efforts, and, in many cases, to reduce costs.

Purchasers have a variety of priorities when working to meet their organisations' needs for products, services, and works, including a need to meet expectations on quality, value, and timeliness for delivery. Sustainability-related aspects can be part of those expectations, informing both what is being bought, and from whom it is being obtained. Procurement professionals can send a signal to the economy by demanding more sustainable products, services, and operations.

Sustainable procurement of buildings and construction is affected by the legislative framework, climatic conditions, market maturity, construction tradition, and access to resources and information. The large variety of building types also add specific features to procurement. Refurbishment projects contain unique boundary constraints, uncertainties or risks compared to new construction projects, which are only constrained by building site and zoning requirements. Therefore, the described procedures always require adaptation to local conditions for successful implementation.

To encourage SP by public authorities, the One Planet Network established a programme on SPP in April 2014. The United Nations Environment Programme (UN Environment), the ICLEI-Local Governments for Sustainability network and the Korea Environmental Industry and Technology Institute (KEITI) co-lead the programme. Furthermore, in April 2015 the One Planet Network established the Sustainable Buildings and Construction Programme (SBC). The Finnish Ministry of the Environment, the Royal Melbourne Institute for Technology (RMIT) and the United Nations Environment Programme (UN Environment) co-lead the programme.



3. Key Concepts

3.1. SUSTAINABLE BUILDINGS AND CONSTRUCTION

Sustainability has environmental, socio-cultural, and economic dimensions. In this guide, the emphasis is on environmental sustainability, primarily with regard to resource use and emissions.

- **Environment:** Buildings and construction have major impacts on our environment in terms of resource use (land, materials, energy, water, etc.) and emissions (greenhouse gases, particulates, waste), and impact on biodiversity (not discussed in this guide). However, the sector can also play an important role in improving the environment by cleaning polluted areas, and recycling not only its own waste streams, but those of other sectors. Sustainable buildings can be planned to minimise and even reverse environmental damage, mitigate climate change and its challenges, and improve resilience.
- **Society:** Social aspects of sustainability involve ensuring occupant health, equitable access, safe working conditions, and fair employment practices - both at the construction site and along the supply chain. Cultural components of sustainability are case-specific and should be considered as part of all projects. Buildings can contribute to human health, safety and comfort, while construction activities can provide employment and innovation opportunities for all genders and all ages. The sustainable procurement of buildings and construction can offer considerable social value by engaging local resources and building capacity.
- **Economy:** Economic sustainability looks at whole-life costs, affordability, and best value for money.

The successful design, construction, and operation of sustainable buildings involves “**life cycle thinking.**” Life cycle thinking broadens the focus of a project from just design and construction to consider the performance of a system or material during the operational phase of a building. It also emphasises the usability and adaptability of buildings for changes in user needs, as well as their careful operation and maintenance.

The aim of sustainable buildings and construction

ISO 15392:2008 defines the sustainable development of buildings and other construction works as bringing about the **required performance and functionality** with **minimum adverse environmental impact**, while encouraging **improvements in economic and socio-cultural aspects at local**, regional, and global levels. Some building standards go beyond minimising environmental damage by attempting to regenerate damaged ecosystems so that buildings contribute more than they take (e.g. the Living Building Challenge).

The aim of sustainable buildings and construction is to create value for owners, users, and society. All stakeholders involved should aim at continuous improvement of their activities, seeking innovative solutions, and better ways of procuring our built environment that meets the needs of current and future generations.

3.2. BUILDING PERFORMANCE

The **performance** of a building measures its efficiency in functioning, and its impact on the environment, surrounding urban environment, and its users. The building’s performance while in use is extremely important considering the long life buildings can have. Some indicators of building performance that directly affect users are: indoor environmental quality (which influences the health and productivity of the occupants), accessibility, safety, adaptability and usability.

As a network of systems and structures, a building is complex to design, construct, and maintain as owners, users and the surrounding community change over time, along with their needs and aspirations. Changing demographics and increasing national sustainability demands also create challenges in providing the desired performance of a building at optimal life cycle costs and GHG emissions.

The construction sector is traditionally focused on minimising the investment costs of buildings at an acceptable

level of quality (primarily regulated by authorities in terms of health and safety aspects) instead of maximising the building's value over its service life, which would involve improving the building's performance against whole-life costs and environmental impacts. This leaves very little space for innovation if the client's business model focuses on competing to deliver "the same product" at the lowest price. Section 4 looks at different business models which allow more flexibility for innovation.

3.3. RESOURCE USE, EMISSIONS, AND HUMAN HEALTH

For buildings and construction to move towards sustainability, it is important to carefully select the resources and building materials according to their social and environmental impact, their related emissions, and value for money (see Section 4). Attention must also be paid to the resources used during the operation of the building, for example energy and water.

Energy is a resource necessary to manufacture building materials and construct a building, as well as operate the building (e.g. lighting, climate control, access control,). As the burning of fossil fuels releases greenhouse gases which contribute to climate change, sustainable buildings aim to minimise the use of fossil-fuel based energy. This can be achieved by reducing overall demand, increasing energy efficiency in buildings through active and passive solutions, and by using renewable energy sources. Passive solutions, such as the shape and orientation of the building, the use of shading, or the choice of insulating materials can minimise the need for energy to heat and cool. Water is another key resource required, and similar water-saving solutions like water-efficient fittings, rainwater harvesting, and grey water recycling should be employed, especially in regions of the world where obtaining fresh clean water is not easy or cheap.

There are many variables to take into account when choosing sustainable building materials. Many of the negative environmental impacts of building materials take place before they are used at the building site. As a general rule, locally sourced and produced materials (e.g. stone, timber, adobe bricks) can provide a lower energy footprint than those transported from a greater distance. **Environmental Product Declarations (EPD)** and **Life Cycle Assessment (LCA)** of materials, when available, provide a means of comparing the performance of alternative solutions. Many EPD and LCAs look at human health, land use, minerals, fossil fuels, acidification/eutrophication, ozone layer, climate change and eco-toxicity. Although some of these effects might not be visible on site, they are indirectly connected to the building and can be influenced by the procurement process.



The design and construction of a building itself can directly influence the health of occupants and users. A design that leads to frequent accidents, or loss of comfort from poor indoor air quality or poorly managed natural and artificial lighting can cause a decrease in the productivity of occupants. This aspect of sustainability is often forgotten, and a “sick building” can cost commercial building users a lot of money over its lifetime. Investing in a healthy building helps to avoid that ongoing expense.

3.4. SUSTAINABLE BUILDING PROCESS AND PROCUREMENT PROCESS

Procuring sustainable buildings starts from setting clear targets for the desired outcome, required performance, and achieved value, as well as defining the budget and environmental constraints. Adding green technologies afterwards to a standard building seldom provides an optimal solution, and typically works out to be more expensive than a building designed to be sustainable from the start.

It is important to work closely with the design and construction community as well as the building’s end-users to investigate which technologies are applicable and available within the budget limits, including for the running of the building. Targets can be set in quantified terms and partners selected according to their ability to meet the sustainability objectives.

The building life cycle is often described as a sequential process where the requirements are set in the building brief and design starts when the requirements are frozen. After the design is complete, construction takes place and once finished, the building is handed over in a commissioning phase, and the operation/maintenance phase begins. In practice, the requirements often change in the design phase and even during construction, due to market changes, budget constraints, changing users, or other reasons. Further, the design and construction processes are often described as sequential tasks, but this is rarely true on the job site as tasks often overlap.

A sustainable building process usually includes these five phases:

1. **Setting the targets:** Objectives should be set for the operation phase to meet changing needs, working with the market, finding the right team
2. **Design:** Sustainable design, outlining the expertise needed, validating that the client’s needs are met
3. **Construction:** Sustainable construction, validating that the original needs are still met, or changed and new objectives set, and the procurement carried out accordingly
4. **Commissioning:** Ensuring that the owner gets what was procured, that the building operates as intended, and the end-users know how to operate the building
5. **Operation:** Careful maintenance, monitoring the performance and user satisfaction, continuous improvement against established targets.

Although the process of procuring new buildings and procuring refurbishment of existing buildings doesn’t differ methodologically, there are important differences. These include different site and scope/boundary conditions, such as plot and zoning of a greenfield or brownfield site vs. an existing building. In many places, different building codes apply, and in some special circumstances, there is a need for historic preservation work on cultural assets. So, while the sustainable procurement concepts apply to both, one should consider the unique constraints, uncertainties, and opportunities afforded by each project.

The refurbishment of existing buildings follows the same procedure as for new buildings, but the difference is that the boundaries are defined not by the plot, but by the existing building. In reality, the process is concurrent, i.e. the parallel activities depend on each other.

There is not one best process to procure sustainable buildings and construction. The client’s skills, market response and legislative issues affect the choice of which model to adapt in order to meet local needs.

4. Project Design and Delivery

Part of economic sustainability in terms of sustainable building construction and procurement is getting the **best value for money**. The UN's Procurement Manual (2013) defines the best value for money as the “*Optimization of whole life costs and quality needed to meet the user's requirements, while taking into consideration potential risk factors and resources available*”. Its goal is to achieve maximum benefit for the organisation. Accordingly, price alone is not necessarily determinative of the best value for money.

In order to determine the best value for money, the following factors need to be taken into consideration:

- **Cost-related factors:** the entirety of the cost components that comprise the total cost of ownership of the acquired goods, services or works, whether direct or indirect, fixed, or variable;
- **Non-cost-related factors:** factors or attributes that are related to the organisation's needs and requirements (e.g. technical merits of the offered goods, services or works, timelines of delivery, competence, reliability, and financial capacity);
- **Market environment:** overall market maturity and availability of sources (e.g. supplier or product availability, market maturity, supplier sustainability);
- **Sourcing:** competitive, fair, ethical, and transparent sourcing that is conducted consistently and in accordance with best practices and UN procurement standards, and within applicable laws; and
- **Risk factors:** any risk that may jeopardise the successful outcome of a procurement and diminish the value that could have been obtained.

(UN 2013)

To obtain the best value for money, procurers often use a **performance-based contract** for suppliers. This is a type of contract whereby requirements are specified in terms of performance and output, and generally include performance incentives and penalties.

There are, generally, three types of criteria that are used to assess submissions from suppliers:

- **Commercial criteria:** These evaluate all cost and non-cost related aspects of the submissions and the acceptance of terms and conditions, including price of goods, services or works, also called “face value”, total cost of ownership, i.e. life-cycle costs of goods or services including maintenance, spare parts, warranty, training, disposal, shipment, financial status and capability of the vendor, non-financial costs and limitation or exception or negotiation of the general conditions on contract.
- **Technical criteria:** These evaluate the goods, services or works offered, the approach to providing them, and the vendor's past performance. The technical evaluation can be reflected, globally or in detail, in the solicitation documents.
- **Management criteria:** These evaluate all business and management-related aspects of the submissions, including management experience, management methods and systems, commitment to quality, personnel qualifications and experience, labour and equipment resources, facilities, finances, and financial management.

(UN 2013)

4.1. PROCUREMENT STRATEGY AND PROJECT DELIVERY SYSTEMS

A **procurement strategy** is the planned approach to purchasing that takes into account the project timeline, funding and budget, the projected risks and opportunities, and other factors. It helps procurement officers to make decisions as to how the project proceeds.



The **project delivery system (PDS)** determines the division of labour, duties and liabilities, and contractual and operational relations between the major players involved in a project. Financing for the project can be arranged by the owner or by the service provider, in which case the owner pays a service fee starting from the commissioning date. This guide does not discuss different financing systems in detail.

Responsibilities during the delivery process are defined in the contracts between the client and the suppliers. If the client is in charge of design and maintenance, and competition focuses on price, the suppliers may have difficulty in proposing alternative innovative solutions that could be better for the client during the operation phase. **The development of collaborative construction project arrangements** has emerged in response to the challenges experienced with traditional contracting. Different variations of project delivery systems are used, and some construction models fit better for certain types of projects. In successful projects, the client's procurement strategy is of utmost importance, together with the skills available on the client side as well as amongst suppliers.

The payment mechanism defines the basis of payment to service providers, and takes into account the kind of risk that is transferred to service providers. The tender evaluation may be based on price or quality, or both; the latter may include the competence and range of services in addition to product quality.

Below is a description of some of the different types of project delivery systems:

- **Design-Bid-Build (DBB):** The owner has contracts separately with a designer and a contractor. The design is completed prior to procuring construction, and a contractor is typically selected based on the bid price (since sustainability, if included in the design and project requirements, is already defined). Repairs and maintenance are commissioned separately.

- **Construction Management (CM):** In addition to a designer, a construction manager is hired by the owner to manage the overall project, and implementation is achieved through numerous partial construction contracts that are entered into in phases as the design progresses. Repairs and maintenance are commissioned separately. Variations include two main options, based on whether the numerous partial construction contracts are held by the owner (CM-at-fee, Construction Management) or by the management contractor (CM-at-risk, Management Contracting) with the owner's involvement in decision making. The construction manager is selected early in relation to design while a target price is agreed on later in the process. Other variations include two main types based on whether the entire project is given to one general contractor to execute, or the project is divided in a few parallel contracts (based on phases and/or fields of technologies: structural, mechanical, etc.) entered into with separate suppliers (Divided Contract, Multiple Prime) with one overseeing coordinator.
- **Design-Build (DB):** A design-build contractor is responsible for the project's design and implementation as a whole. The quality or features of a design proposal may be a selection criterion in addition to price. Repairs and maintenance are commissioned separately. Variations exist according to the degree of the client's design and scope of services (e.g. Turnkey, Design-Draw-Build) and the position of the client's early stage designer (if any), i.e. possibly continuing as the owner's adviser (Develop-Construct) or being subordinated to contractor taking care of detailed design (Novation Contract).
- **Design-Build-Operate (DBO):** The responsibility is assigned through a single contract to design, build, maintain, and/or operate the asset for the contract period. The means of competition are varied. The owner arranges the financing and pays for the investment in due time (as in CM, DBB, AC and DB). Variations include different options as to the scope of services included in the contract, e.g. in addition repairs and maintenance, facilities services, and various user services may or may not be included in the contract (cf. Design-Build-Maintain, Design-Build-Operate-Maintain).
- **Design-Build-Finance-Operate (DBFO):** The responsibility is assigned through a single contract to design, build, maintain, and/or operate the asset for the contract period. The service provider also arranges the financing and the (future) owner repays the investment as part of the service fee starting from commissioning. Variations include numerous options depending on conditions of transfer of ownership of the facility to the owner, as well as the scope of services and concession rights included into the contract, in addition to scope-based naming practice (e.g. B(O)OT, Build-(Own)-Operate-Transfer). Also other more general concepts are used to refer to the system (PFI, Private-Finance-Initiative; PPP, Public-Private-Partnership).
- **Alliance Contracting (AC):** The delivery is based on a joint contract between the key parties to a project, the owner, the designer, and the contractor, whereby the parties assume joint responsibility for the design and construction of the project to be executed through a joint organisation, and where the parties share both positive and negative risks related to the project. Repairs and maintenance are commissioned separately. Variations seem to draw a distinction between models that stick to the alliance principles of risk sharing and no-disputes completely, and models that make compromises as to the principles (Pure Alliance, Hybrid Alliance). Another criterion is how the team is selected: early selection based on quality (Single target cost; Non-price selection) or later based also on target price (Dual target cost; Full price selection).
- **Project Partnering (PP):** PP arose from the need for a closer co-operation between too-often adversarial project parties. Methods used to facilitate trust and mutual understanding included partnering workshops, partnering charter (main principles of cooperation in writing), agreed performance measures (and the regular monitoring of those), incentivised payment basis and establishment of suitable processes to deal with disputes, etc. Also, a multi-party contract is sometimes used and, occasionally, the term may be used to refer to alliance-type arrangements. Yet, the roles and liabilities of the parties remain largely the same as in traditional systems despite the strong team integration and openness introduced by the model. Consequently, partnering, as generally understood, is a supplementary approach based on customary contractual structures (e.g. DBB, DB) with special emphasis on the team integration.
- **Integrated Project Delivery (IPD):** IPD is a more recent invention for the efficient utilisation of versatile expertise for the best of the project. While openness, shared risk and reward, and collaborative decision

making are features of an IPD approach, the most striking capacity is probably the early involvement of numerous key participants to jointly develop and validate project goals and design through a multi-party contract. IPD also associates itself clearly with the nascent tools, techniques, and procedures (Building Information Modelling, BIM; lean design and construction). Thus IPD is a form of alliance contracting, but includes also other characteristics that have not been incorporated in the AC philosophy. As the practice has not yet developed that far, most projects seem to apply some sort of hybrid of the traditional and the AC practice.

- **Two Stage Open Book:** Here the suppliers are invited to bid on the basis of an outline brief and cost benchmark, and the winning team creates a proposal on the basis of an open book cost as a benchmark for a second stage.
- **Cost-Led Procurement:** This is a framework agreement with suppliers to work collaboratively to deliver on the first project. In competition, integrated framework teams are given the opportunity to develop their bids with the client team.
- **Integrated Project Insurance:** This is a competition to appoint the members of an integrated project team responsible for the delivery. There is third-party verification of the scheme, through a series of gateways.

There isn't one single project delivery system best suited to sustainable procurement in all conditions. It is important to ensure that sufficient expertise on sustainable buildings and construction is gathered in the project team, and that enough market information is available when choosing the procurement strategy.

If the owners are familiar with the best available technologies, they may choose Design-Bid-Build (DBB) or Construction Management (CM) contracts, not expecting major improvements to be proposed by the suppliers. In this case, the designers have opportunities for innovation in their design, and also for requirement setting in collaboration with the client.

If the owners expect that the market is more familiar with the latest technological possibilities, other procurement models can be applied, e.g. competitive Design-Build (DB) or Design-Build-Operate (DBO) where innovation space is bigger amongst suppliers. Then innovative building systems can be developed to fit with different client briefs, without pre-set designs constraining material solutions, for example.

Alliance Contracting (AC) offers opportunities for new solutions with early involvement of key actors. Project partnering is an example of AC, arising from the need for closer co-operation between the too-often adversarial project parties. In these cases, detailed design solutions may be fixed later on, and the overall performance can be discussed and developed in collaboration with the team comprising of multi-skilled and competent members. This is contrary to procedures where different design disciplines start their tasks "as late as possible" to minimise their design costs, which may lead to more design changes in the design process, which in turn are often sensitive to defects and can be costly to correct.

Competitive dialogue, procurement workshops, design competitions, and different modes of partnering can lead to solutions that best serve the needs explicitly expressed in the beginning.

4.2. SETTING THE TARGETS

Once a procurement strategy has been chosen (see Section 4.1 above) and adapted if necessary to overcome barriers in traditional procurement procedures, targets should be set for performance, value, costs, impacts, and risks.

The team should seek continuous improvement, looking for best practices in local markets and building the capacity of the procurement team. Keeping a close eye on developments in science and products is important as technology develops fast, bringing with it new options, improved performances and reduced costs. Innovations can only be proven to work if they are designed and constructed.

Examples of target setting

- ‘The Hive’, UK: Targets were clearly defined and ongoing negotiation through a Private Finance Initiative (PFI) and a competitive dialogue process allowed bidders to see and share the vision and develop solutions before beginning the real design work. An ambitious CO₂ emissions target of 15,8 kgCO₂/m² was outlined and, other Key Performance Indicators (KPIs) were included in the operating contract with a risk of financial penalty.
- Prison construction, Scotland: The bidder experience of including community-benefit involvement within the construction project was tested. The key focus areas were recruitment and training, the involvement of small and medium-sized enterprises (SMEs), and the involvement of the third (voluntary) sector. The client hosted a ‘Bidders Forum’ and provided an example format of an ‘Employability and Skills Plan’.
- Renewal of the Koemarkt in Purmerend, the Netherlands: Instead of traditional, single-stage, lowest-price, lump-sum procurement, the client wanted to procure based on the Most Economically Advantageous Tender. A cost-led procurement approach was used whereby a maximum budget was set, with the contract awarded to the tender of the highest quality. After the pre-qualification process, the top five bidders were invited to develop a preliminary design, from which the list was reduced to three tenderers who produced a detailed design, and from which the winning bidder was chosen. The local community was invited to choose the winner in a referendum.
- Communication hub campus, Germany: The client wanted to build a campus to act as a communication hub for the local population and fulfil high environmental and socio-economic demands. A PPP was established for the design, build, financing and operating of a school for 30 years. One of the main goals was to achieve passive house standards with the maximum heating demand of 15 kWh/m²/a.

4.3. WORKING WITH THE MARKET

The success of a project will depend on the ability of the building professionals, building owner, and end-users to develop and implement the best solutions. Communicating the goals to the market before the tendering process begins shows the intention to reward sustainability. Engaging with the market is about encouraging partnerships between suppliers by running industry days and publishing online directories. When conducting early market



engagement processes, it is important to protect the efforts of the design and construction community by safeguarding intellectual property rights.

An example of working with the market can be found in a drive for innovation in heating technology in Oslo schools, in Norway. The Oslo city council decided that fossil fuel use in Oslo's schools should be phased out, and they started to look at alternatives. They invited stakeholders to a dialogue conference to find the best heating solutions and gained a lot of useful information. The tender process began with a workshop for suppliers where the tender documents were presented. Four winners were selected offering solutions involving biogas, solid biofuel, heat pumps and solar energy, as well as process innovations.

Another example deals with a procurement prospectus in the UK. The Wakefield council started to develop a strategy to procure a highly energy-efficient lighting system for a new swimming pool and leisure complex. They made a procurement prospectus available to the market, providing details on their proposed project and inviting suggestions from all tiers of the supply chain to come forward with innovative proposals. The most promising responses to the prospectus were followed up with workshops. A directory of businesses that responded was published online to encourage partnering between suppliers in preparation for the call for tender.

4.4. PRICING SYSTEMS

The basic pricing types for a contract are as follows:

- **Lump-sum/fixed-price contract:** The contractor is paid a fixed price agreed upon prior to the commencement of construction, and altered only by changes in the work/scope; the sum is aimed to cover anticipated costs and profit, and the contractor carries the cost risk.
- **Cost-plus-fee contract:** The contractor is paid for actual direct costs of material and labour incurred in constructing the project, plus a separately stated fee for its services; the fee is for the constructor's overheads and profit, and is stated as a fixed fee or a percentage of the costs.
- **Target price contract:** The contractor is paid according to cost plus fee contract with the exception that any cost under-run or over-run against an agreed target cost level is split in pre-agreed, specified proportions between the owner and the contractor.
- **Guaranteed maximum price contract:** The contractor is paid according to the principles of a target cost contract, but only until a pre-agreed guaranteed maximum price (GMP); often there is no separate target cost defined but the GMP under-run is split between the parties.
- **Service fee contract:** The contractor is paid for its services from the commissioning date until the end-of-contract period, and the owner amortises the investment only as a part of the subsequent service fee, which is also typically adjusted based on the service quality.
- **Performance-based contract:** The contractor payment is tied to meeting specific, defined performance indicators. For example, if the building meets (or exceeds) energy performance goals, the contractor is paid additional monies. This can act to incentivise over-all quality and performance of the building.

The most economical solution can be chosen based on the cheapest delivery, the lowest overall costs, or the best value for money. In the last option, the criteria regarding quality can include low-carbon construction or low-carbon refurbishment, or indicators of energy, material and water use.

Risk assessment is an important feature in contracts. For example, risks and savings were shared in Jyväskylä in Finland, in a tender for a contractor to design, build and operate facilities to enhance efficiency. The essential new element in life cycle procurement was to transfer the risk of exceeding the agreed limits of energy consumption from the customer to the service provider. On the other hand, if consumption came in below the limits set, the savings would be shared 50/50 between the client and the service provider.

4.5. SELECTING THE TEAM

The selection of the building team, the designer, and the constructor – either separately or as a consortium – is a crucially important step. For this purpose, the owner usually solicits tenders from the market.

The starting point can be one of the following:

- **Sole source or negotiated procedure:** The tender is solicited from a single tenderer selected by the owner.
- **Quotation procedure:** Tenders are solicited from a few candidates selected by the owner in any reasonable and fair way decided by the owner.
- **Qualified procedure:** Tenders are solicited only from candidates who have expressed their interest as a result of advertisement and meeting prequalification criteria.
- **Open procedure:** Any party having the requested capability may submit a tender in response to a public advertisement by the owner.

Examples of team selection

- The National University of Ireland, Galway: This is an example of co-operation in design, where the design team was procured through a competitive public procurement process and the main contractor through public procurement, utilising a restrictive process. In regard to the building design, the University's staff members, building managers and end-user occupants were invited to engage in the design process. The contractor also contributed to discussions on design and buildability to ensure the quality of the final building.
- Kindergarten in Vinovo, Italy: A public-private partnership was applied for, in a specific form involving tendering jointly for the design and build, as well as financing the construction. This was a leasing contract with the funder of a set duration, over which period the authority would pay leasing fees for the use of the building. At the end of the leasing contract, ownership of the building passes to the authority. This was a design and build contract with a construction company, managed by the financing organisation.
- Multi-functional sports centre, Collesalvetti, Italy: The municipality published a tender for the award of a 45-year concession for the design, build and operation of an existing multi-functional sports centre. Construction companies were invited to join a two-phase competitive dialogue, based on an initial plan prepared by the authority. In the first phase, each pre-selected company was invited to propose amendments to the initial proposal. In the second phase, the same companies were invited to tender for the construction work and operation based on the revised plan.

4.6. CLIENT RESPONSIBILITIES

Before starting a new project, it is important that there is a clear understanding of the client or building owner's duties. These are as follows:

- **Organising the control of work**, which is often commissioned to a consultant and is influenced by the type and contents of the contract as well as the contractor's own quality management and assurance;
- **Ensuring conformity to law** and building codes, which includes tasks related to obtaining building permits and authorities' inspections, and looking after the service providers taking care of related tasks;
- **Paying for the services**, which, in the case of an owner-financed project, is typically as the work progresses, whereas in cases where the service provider arranges the project financing, payment is made as service fees are incurred;
- **Announcing relevant information**, which refers to the owner's duty to inform service providers about relevant project information and ensure the accuracy of information given; and

- **Contributing to the progress of the work**, which means that the owner is obliged to take charge of timely execution of separate procurements and other related tasks that are not part of the contract but have an influence on it.

An example of being an intelligent client comes from passive social housing in southwest Finland. Ambitious objectives to meet Finnish Passive House criteria meant that two procurement clinics were held for potential builders and technology suppliers, and open, interactive workshops were held to facilitate market dialogue between potential service providers, consultants, and investors. The clinics also included a customer satisfaction survey, and future inhabitants were trained in energy-saving measures.

Another example is an advisory service for municipalities in Voralberg, Austria, where all 96 member communities wanted to renovate or construct energy-efficient or eco-friendly buildings. They were supported by experts through the entire planning, tendering, and building process. The service consisted of four modules: pre-planning, planning and tendering, control and execution, and control of success. Energy savings of around 70% and a reduction of indoor air emissions of 90% have been achieved.

In a third example, the region of Alsace in France wished to establish a long-term contract for the running of 14 high schools to take advantage of potential energy savings. As the administration had little experience in energy performance contracting (EPC) or public private partnerships (PPP), it was decided to bring in external experts. The services of technical, legal, and financial experts were procured to assist in developing the most suitable model. The final outcome was a PPP running for 20 years with a value of €64.6 million. For the first three years of the contract, the experts were still available to supervise contract implementation.

A final example is given about working with the local energy agency in Avigliana, Italy. The city wanted to set an example of good practice for citizens. A three-year contract was signed for the collection of data on the energy performance of the city building stock, maintenance requirements, and an assessment of end-user needs. Then another contract was signed for 25 years with a minimum target of a 29% reduction in energy consumption. For savings of 30% to 35%, the contractor would receive 60% of the extra savings, and for savings exceeding 35%, the contractor would receive 75% of the extra savings.

5. Building Certification Schemes, Indicators and Legal Frameworks

Sustainability assessment of buildings can be done using simulation or calculation methods using measured data. **Life Cycle Assessment (LCA)** reports on the environmental impacts, and **Life Cycle Costs (LCC)** or **Whole Life Costing (WLC)**, communicates the economic costs. The value of a building depends on a number of parameters, including the location, environmental and economic impacts, branding, and its performance in use. The achieved performance covers issues like indoor environment quality, which includes thermal comfort (ambient temperature, humidity and air velocity), visual comfort, acoustic comfort, and indoor air quality. It can also address aspects of adaptability, usability, or accessibility. These parameters can be measured by **investigating the building** itself, and by asking the users through a **Post Occupancy Evaluation (POE)** or other survey method.

Section 5.1 describes commercial certification schemes that can be used to obtain an estimate of sustainability with the help of indicators. The certificates may influence the market value of buildings, with higher values being associated with buildings that achieve higher levels of certification. Section 5.2 introduces two simple certification schemes that can be used on a wide range of projects, and Section 5.3 explains the use of a small number of core indicators in sustainability assessment that can still help to obtain reliable results. Section 5.4 looks briefly at prescriptive vs. performance-based legal frameworks, which can play an important role in determining a building's sustainability strategy.

5.1. BUILDING CERTIFICATION SCHEMES

Different components or aspects of buildings can be certified or classified, such as Environmental Product Declarations (EPD) for building products, or energy certificates for estimated energy consumption. Emission classification can be given to building materials, cleanliness classification for air-handling components, etc.

This section deals with the assessment systems, rating tools and certifying schemes that assess the sustainability of buildings. Some examples are listed below in alphabetical order, along with their country of origin.

- BREEAM, UK (Building Research Establishment Environmental Assessment Methodology)
- CASBEE, Japan (Comprehensive Assessment System for Built Environment Efficiency)
- DGNB, Germany (German Society for Sustainable Construction⁷)
- EDGE (Excellence in Design for Greater Efficiencies)
- GRIHA (Green Rating for Integrated Habitat Assessment)
- GSAS, Qatar (Global Sustainability Assessment System)
- Green Star, Australia
- HQE, France (High Quality Environmental standard⁸)
- LEED, US (Leadership in Energy and Environmental Design)
- Pearl rating system, Abu Dhabi UAE
- SBToolCZ, Czech Republic
- SHERPA (Sustainable Housing Design in the Global South)

The names of these systems reflect either the developer (BRE, DGDB) or the emphasis of the assessment (energy and environment, efficiency or sustainability). The systems evolve over time and new versions may contain features not found in the previous ones.

⁷ Deutsche Gesellschaft für Nachhaltiges Bauen

⁸ Haute Qualité Environnementale

These certification systems consist of a number of metrics that indicate the characteristics of the measured features. The indicators have weightings, meaning that some aspects are considered more important than others. The weightings are allocated through consultation with different expert groups. They typically focus on environmental aspects (e.g. energy, water, material, transport), social aspects (e.g. health, indoor environmental quality) and some of them also economic aspects (e.g. value). When the first certification schemes were launched in the early 1990s (e.g. BREEAM, HQE and LEED), they were mainly applied in their country of origin only. Each country willing to assess their buildings started to develop their own system to best fit their market environment, taking into account local climate, building tradition, availability of information, scarcity of resources, etc.

Certification systems award points for each indicator assessed, and then sum them up into a total score. The score can again be communicated as part of a range, expressing it as “Good”, “Gold” or similar. In that way the property owner or investor may set a baseline for their assets. The indicators and weightings vary depending on the building type (e.g. housing, offices, schools, hospitals, etc.), the nature of the project (e.g. new build vs. refurbishment) and the scale of the project (e.g. buildings, neighbourhoods, or cities).

To give an example, the Japanese CASBEE system uses an eco-efficiency approach in their assessment. It separates the output (environmental quality and performance) from the input (environmental loading). Dividing the output (indoor environment, quality of services and outdoor environment on site) by the input (energy, resources and materials, offsite environment) results in a building eco-efficiency (BEE) figure as shown in Figure 1 below. It also shows the evolution of building technologies using factor thinking. CASBEE can also be used to assess the sustainability of vernacular buildings, and has a version for market promotion.

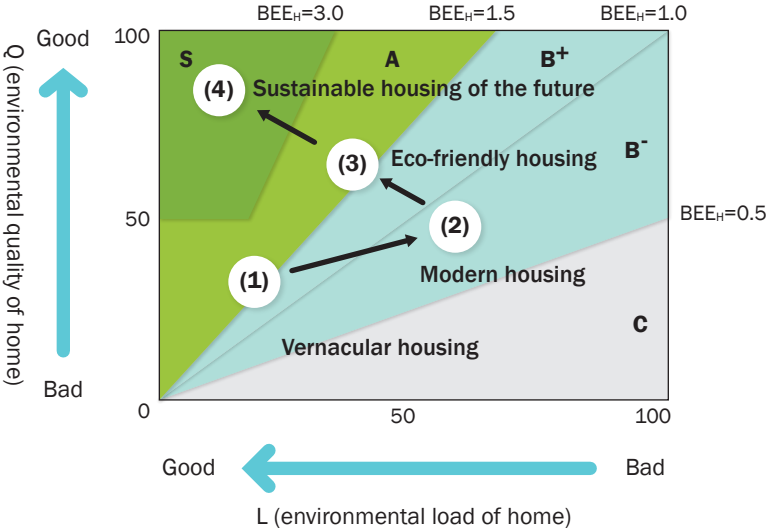


Figure 1: Comprehensive Assessment System for Built Environment Efficiency (CASBEE) assessment

The relevance of such certification schemes depends on the applicability of the system to the measured object. If the rating is based on technological systems (e.g. mechanical ventilation) that are not used in the building or if the highly weighted parameters have low significance (e.g. water in areas of high rainfall) or if the information is not available, the score does not fit the purpose well. Therefore, some schemes also have an “international” version that can be applied as a starting point before the system is localised to meet the needs of the market environment in question. Some examples of international initiatives include:

- In South Africa, the Australian **Green Star** was customised to fit the country’s built environment and property market. It took 25 technical consultants a year to customise the system. The South African rating has been applied in other African countries, e.g. Ghana, Namibia, and Rwanda.
- The American **LEED** certification approach has been applied in over 100 countries, and offers, for example, a customised version for Canada

- The British **BREEAM** has country-specific schemes that are either adopted or in the process of being adopted in the Netherlands, Spain, Norway, Sweden, Germany, Austria, Switzerland, and Luxembourg (see Figure 2).
- The German **DGNB** has partnerships for adaptation in Bulgaria, Denmark, Austria, Switzerland, and Thailand. They also have localisation routes through DGNB communities in Brazil, China, and Russia. DGNB has been applied in over 20 countries.
- **SBToolCZ** has been developed from an international SBTool framework. Other developments from the same origin are Protocollo ITACA in Italy, SBToolPT in Portugal, and Verde in Spain.
- The Japanese **CASBEE** has been used for certification in China
- The French **HQE** has been applied in Morocco.

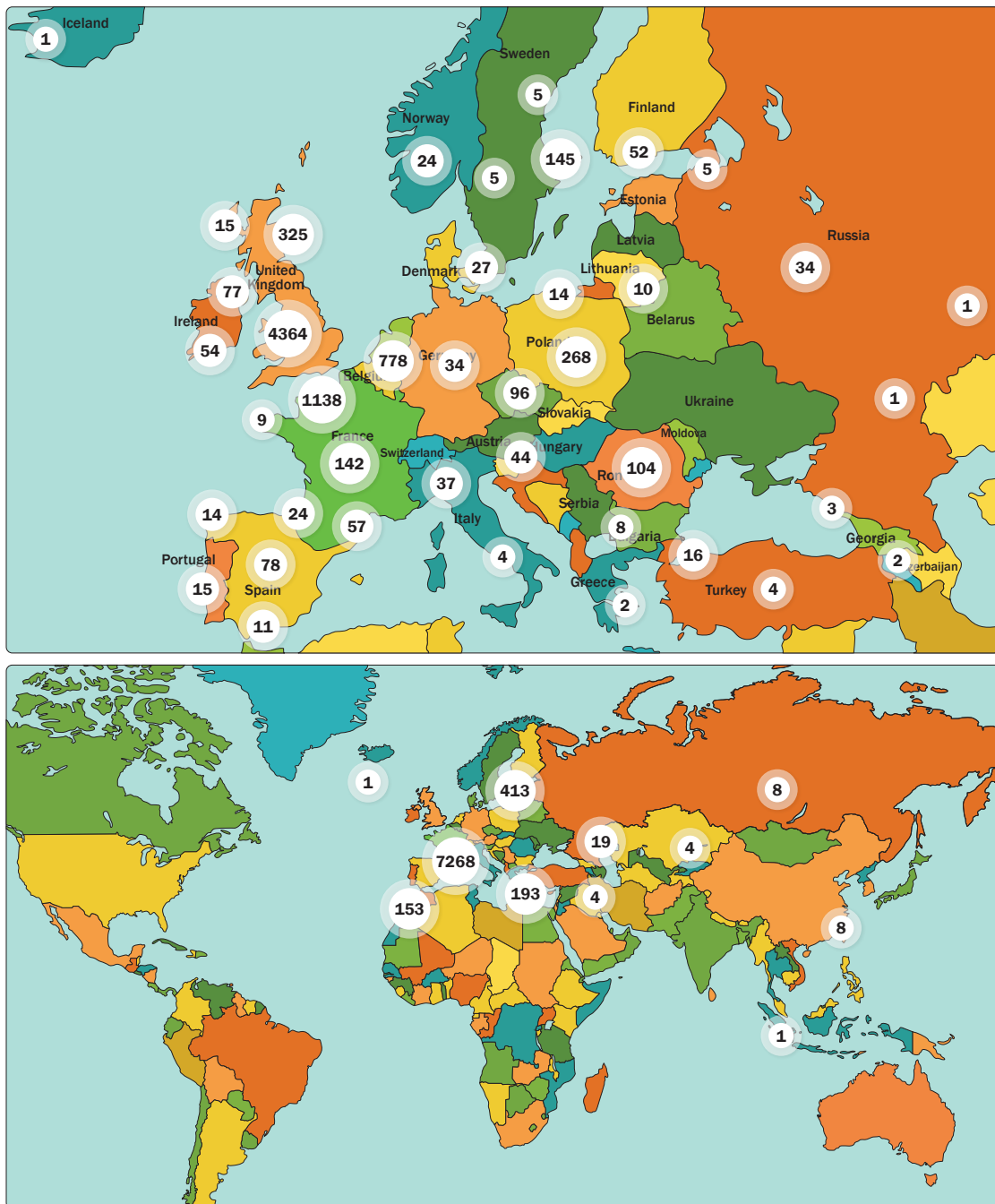


Figure 2: The number of Building Research Establishment Environmental Assessment Methodology (BREEAM) certified projects in Europe and worldwide (at time of writing)

In many countries, several certification schemes are used at the same time with or without local customisation. In different markets, especially in developing countries and emerging economies, a certificate as such does not necessarily give a good indication of the sustainability of the building if the indicators measured are not relevant to the sustainability challenges and opportunities presented by local conditions.

The certification approach may structure the sustainable design and construction process by pointing out issues to consider during procurement, especially if such practices are not well known to the client. In developed markets, building regulations or market practices may be such that applying for certification using an imported scheme doesn't necessarily improve the sustainability of the building. An ordinary building located next to a metro station may already provide enough points for a certificate. However, the certificate could still be beneficial in terms of improving the property's market value or the client's corporate image.

5.2. SIMPLE CERTIFICATION SCHEMES

The **Sustainable Building Assessment Tool (SBAT)** (see Figure 3) developed in South Africa consists of an Excel-based assessment tool and manual. It assesses the built environments that people live in, such as houses, apartments and their neighbourhoods, and supports an integrated and responsive approach to achieving high sustainability performance. The tool is based on a holistic methodology for addressing sustainability and includes social, economic, and environmental criteria. It is easy to use and particularly suited to developing country contexts.

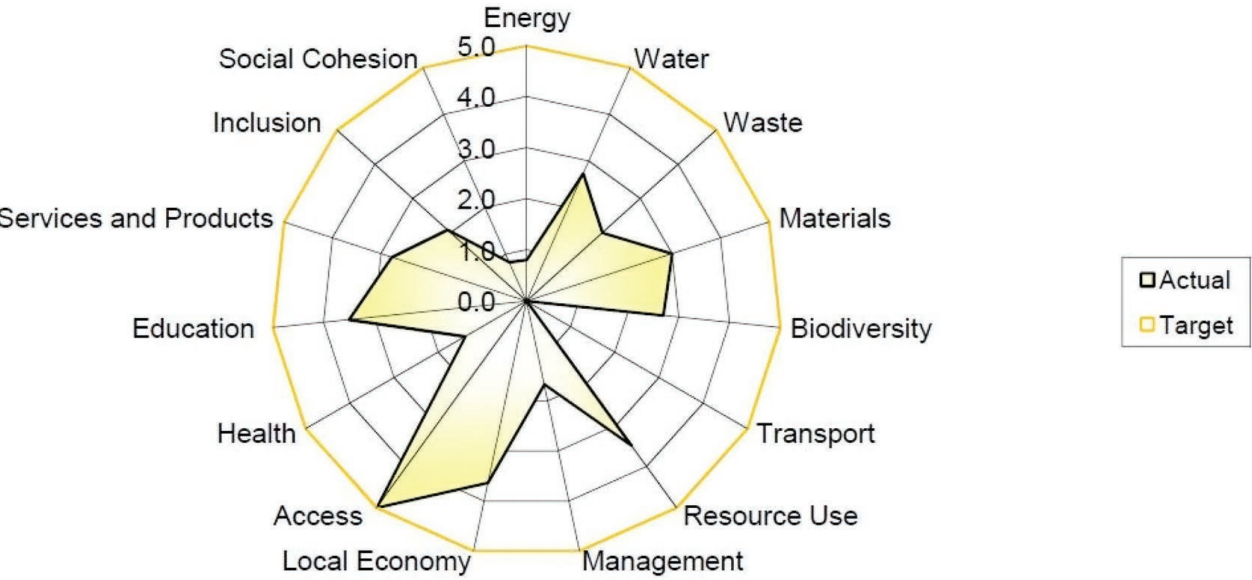


Figure 3: Sustainable Building Assessment Tool (SBAT) Residential Design

Another example of assessment tools for developing countries is **SHERPA**, a self-evaluation tool for project managers, communities, and other stakeholders involved in the planning, design, construction, and assessment of housing projects. Its goal is for housing in the 21st century to respond to the transformative aspirations of the New Urban Agenda, the 2030 Agenda for Sustainable Development and the Paris Agreement. SHERPA can be used to identify and analyse the strengths and weaknesses of new, current, and past housing projects, allowing the achievement of a more sustainable outcome. It is available for users to test for free.

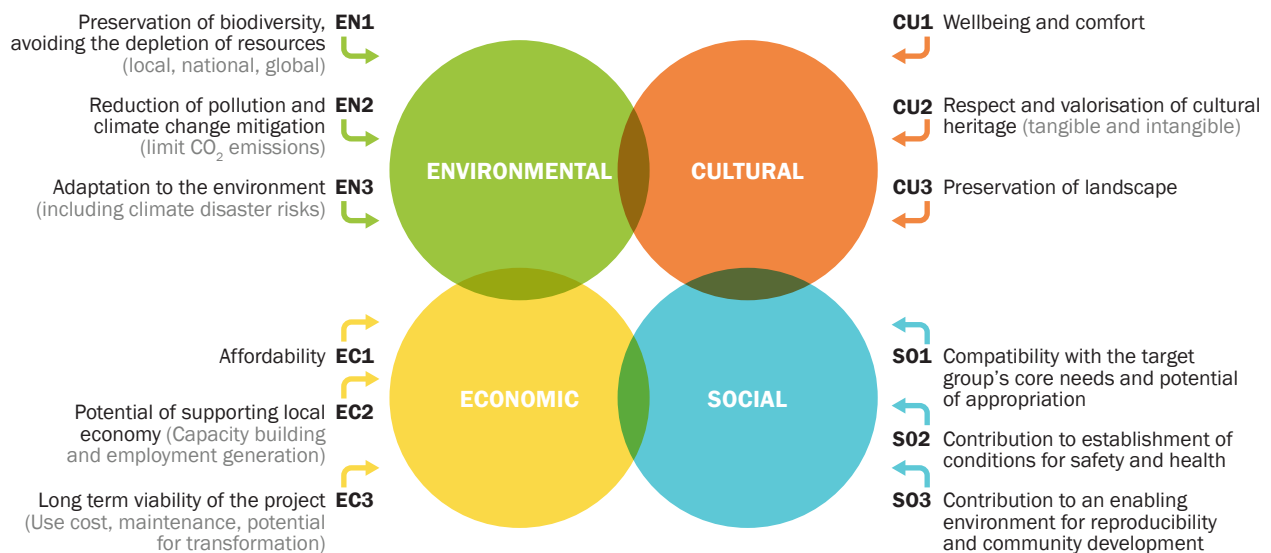


Figure 4: SHERPA sustainable housing tool

5.3. THE USE OF CORE INDICATORS

The European Commission has developed a voluntary reporting framework that provides a common "sustainability language" for the buildings sector, called **Level(s)**. It is a set of simple metrics for measuring the sustainability performance of buildings throughout their life cycle, encouraging life cycle thinking at a whole building level. It is a comprehensive toolkit for developing, monitoring and operating, and supports improvement from design to end of life. Level(s) uses robust indicators based on existing tools and standards, and covers energy, materials, water, health and comfort, climate change, life cycle cost and value. The system is applicable to commercial and residential buildings. Sustainability tools and certification schemes can use it as a module within their products.

The following guiding principles should be used as the starting point for the choice and development of sustainable building indicators (Crowhurst et al. 2010):

1. **Openness and transparency:** The framework will clearly demonstrate applicability to ensure consistency and fairness of application
2. **Consistency:** Measurement for the whole building on its site (but excluding surrounding infrastructure)
3. **Modularity:** Measurement over the building's full life cycle broken down into modules; the before-use (Construction) stage; in-use (operational) stage, and end-of-life stage; and with each module capable of being assessed and reported independently
4. **Pragmatism:** A 'core' set of preferred measures that are possible now
5. **Auditability:** Metrics can be independently assessed, where this is required
6. **Realism:** The 80:20 rule applies – it is not possible to include absolutely all contributions to each metric in the framework (and it would be too costly to do so)
7. **Flexibility:** Allowing for inclusion of other additional 'optional' measures, acknowledging (and allowing for) local procedures and processes (e.g. methods, national regulations etc.), and encouraging transparency - particularly in additional optional measures.

A framework of common metrics for buildings was proposed by the Sustainable Building Alliance with six core indicators. The two resource depletion indicators are primary energy and water. The two indoor environment quality indicators are thermal comfort and indoor air quality. The two building emission indicators are greenhouse gas emissions and wastes. These indicators should be assessed at before-use and in-use stages.

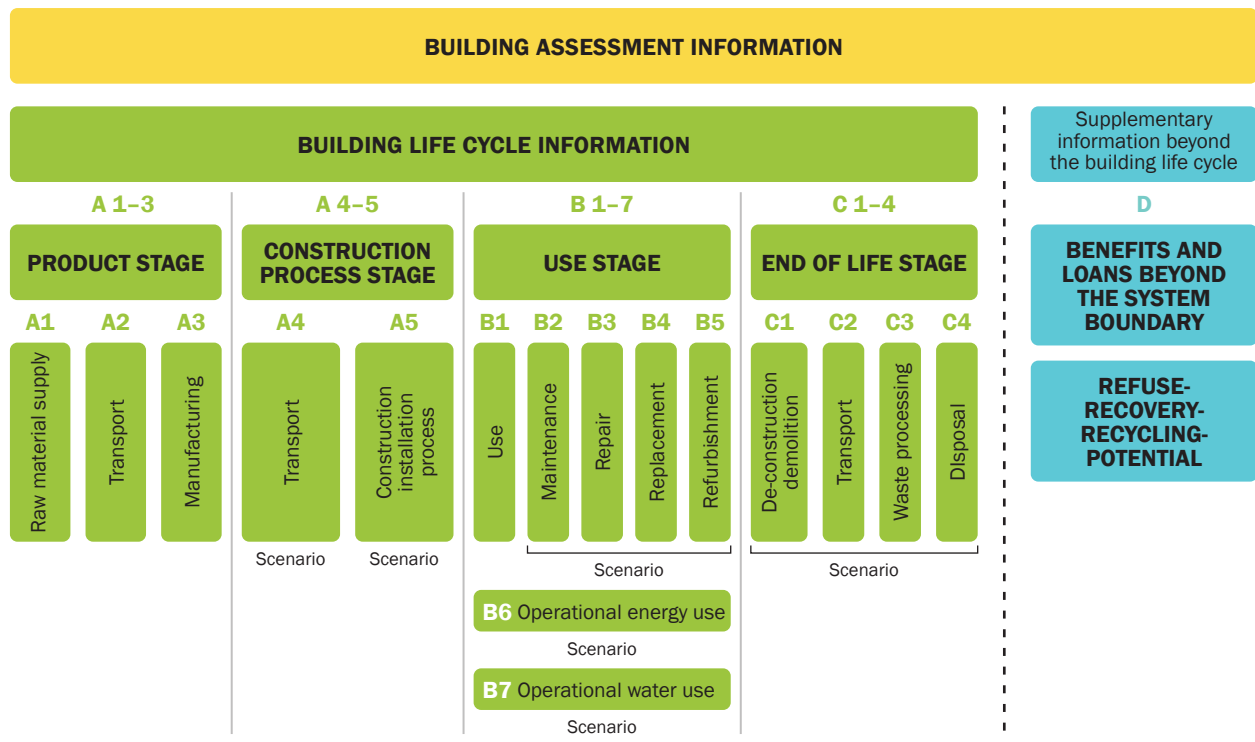


Figure 5: The life cycles

Level(s) is an example of the use of standardisation-supported core metrics consists of six priority areas:

- Greenhouse gas emissions throughout the building's life cycle
- Resource efficiency and circular material life cycles
- Efficient use of water resources
- Healthy and comfortable spaces
- Adaptation and resilience to climate change
- Life cycle cost and value

Each indicator can be used for different types of performance assessment, from a basic level through to a full Life Cycle Assessment (LCA). The intention is to create a common language for sustainable building, and to support resource efficiency, a circular economy, and green growth.

Different tools can be applied during the assessment, e.g. to obtain quantified values for any indicators that are requested. **Building Information Modelling (BIM)** is increasingly used in building design. Forming the model using the sustainability data in an interoperable format (IFCs) provides opportunities to perform sustainability simulations easily during the early phases of design (energy, CO₂ emissions, etc.), thus enabling design iterations early in the process to improve the life cycle performance of the end product. Linking core metrics with construction product manufacturers' BIM e-Catalogues provides LCA results and links the sustainability information with the product data.

Using core indicators in the sustainable procurement of buildings is a promising approach when the small number of indicators are sufficiently representative of sustainability. When enough product information can be obtained from the manufacturers and the building design is created with interoperable tools, the error-sensitive and time-consuming manual work can be decreased, and the assessment can be simplified and speeded up.

5.4. LEGAL FRAMEWORKS

In many countries, building laws have been developed to include sustainability-related criteria to ensure a base standard for the sustainability of new buildings regardless of whether the client wishes to pursue certification or not. Legal frameworks aimed at improving the sustainability of buildings follow either a prescriptive approach or a performance-based approach, or sometimes a combination of the two.

The traditional **prescriptive approach** describes the way a building must be constructed instead of the outcomes of the building process, and it is related to type and quality of materials, method of construction, and workmanship. Such an approach is strictly mandated by law, codes, standards, and regulations, and is based on past experience and consolidated knowledge. The writing of prescriptive codes and standards usually follows accidental injury or death, so as to avoid a repeat or consequence of a hazardous situation, or in response to a recognised social need.

When the building design is simple or proven technologies are used, the use of prescriptive codes can result in more effective, efficient, or less costly solutions, which is beneficial in many situations. Around the world in the public and private sector, research is being done to create a different set of codes, methods and tools based on performance criteria to complement the traditional prescriptive codes.

Using a **performance-based approach** does not preclude the use of prescriptive specifications. Although the benefits of adopting a performance-based approach are significant in terms of ensuring that the building performs sustainably, employing this approach at any stage in the building process is more complex and expensive than using the simpler prescriptive route. So, the application of this approach should not be regarded as an end in itself.

For complex projects, the use of the performance-based approach is indispensable, in particular during design and evaluation phases. However, it is not likely that a facility will be planned, procured, delivered, maintained, used, and renovated using solely performance-based documents, because there is not yet enough experience with this approach. It is important to keep in mind that the prescriptive approach can stifle changes and innovations, so it may be best to blend both approaches during the process. For more information on performance measurement and simulation approaches, see Section 6.

6. Performance Measurement and Tracking

6.1. CONCEPTS IN PERFORMANCE MEASUREMENT

Presently, the majority of work on performance measurement is tied to building energy use, but it is important to consider the use of other resources such as water and materials, and outputs of waste. While many certification schemes require measuring and tracking a variety of resources, a majority of approaches and products available on the market were originally developed to target energy use. As such, this section pulls from this experience but the approaches and examples are applicable to other resources too.

Current approaches for energy management and operation in buildings are based on Energy Data Management (EDM) techniques that act in a reactive way to previously unknown changes. In order to increase efficiency in building energy management, “predictive” approaches must be used by generating knowledge from historical data and forecasting to manage the building behaviour in advance.

Energy audit

The term energy audit is used for different kinds of energy studies or investigations, sometimes leading to confusion. The recent development of International Energy Management Standards, ISO 50001, has provided some clarification, definition, and standardisation of terms. ISO 50001, as well as other International Standards such as ISO 14000 (Environmental management), is based on the PLAN-DO-CHECK-ACT model for continual improvement. It provides the processes and systems needed to incorporate energy considerations and energy management into daily operations as part of an organisational strategy for improving energy performance. An “energy review”, presented by the ISO 50001 standard, establishes the baseline data on the energy use of the enterprise, building, etc. This activity is usually carried out once prior to the development and establishment of the energy management strategy, and it requires data acquisition.

Simulation Based Control

Simulation Based Control (SBC) or Model Based Control (MBC) is a control method that uses the outputs obtained by running simulations and analysing their results to calculate control actions, and has been used for decades in the process industry by oil refineries, chemical plants, and others. Simulation models of the Heating, Ventilation and Air Conditioning (HVAC) systems and rooms are very often used during the planning phase of a project for a proper system design. Physical models of the processes are used to obtain control strategies for optimal plant operation. These simulation tools offer additional possibilities for control algorithm development and performance observation which are not used in practice in buildings thus far.

The use of model-based control for buildings, where models can be considered as complex objects with many unknown boundary conditions, is still very limited. Developments in this field include simple control systems, for example radiators in test room configurations analysed by building simulation tools, and optimal controllers designed for wind turbine control, and experiments carried out for model-based control of heat exchangers and humidifiers in air conditioning systems for car painting processes. The potential of optimisation-based control to reduce whole building energy consumption between 10% and 20% has already been demonstrated in small-scale demo buildings. Nevertheless, despite these past experiences, physical models of buildings are still rarely used for advanced building control in real operation, as their handling is considered too cumbersome.

The development of operational plans based on energy management strategies requires a level of available information and technical knowledge that is not always in place. Building operation anomalies, such as simultaneous heating and cooling or improperly operated economiser cycles, cannot easily be detected without direct measurement of indoor and outdoor loads (which is not always feasible). Moreover, the impact assessment of, for instance, alternative operational plans or corrective actions is usually not possible, unless considerable time and effort is spent in energy audits and/or simulations.

Simulation or Model Based Control can be used for maximising the performance as well as improving the efficiency of building operational plans. For instance, a commonly used building control strategy is based on the

efficient use of night-time ventilation, or other active systems like chillers, to pre-cool the rooms and reduce cooling loads during the following day. This significantly reduces the typical peak cooling load during the early afternoon of the following day. However, care has to be taken to avoid the active or passive cooling of rooms during night-time when it is expected that the ambient conditions suddenly change, and no cooling energy would be required during the following day. To avoid this, predictive simulation tools can be used which consider the weather prediction from a web service to analyse the most efficient control strategy of the HVAC system for the following days.

Moreover, discrepancies between the control actions that are actually implemented in a BEMS and those that were intended during design can have a significant energy consumption impact. By using prediction and optimisation strategies to update control strategies at regular time, an adjustment of the traditionally fixed set-points for HVAC equipment can be achieved under favourable environmental conditions to reduce boiler and chiller operating costs while maintaining the heating and cooling demand of the building.

Fault Detection and Diagnosis (FDD)

Most building equipment diagnostics and energy performance monitoring are done in remote monitoring centres, often managed by major original equipment manufacturers. There, small teams of experts – in response to alarms sent by the equipment control systems – manually analyse detailed operational data to identify and resolve problems. In most commercial implementations, the experts rely on domain knowledge, experience, and simple trend analysis. Usually, existing diagnostics methods respond to gross problems identified by alarms and focus at component level. As a consequence, inefficiencies caused by improper operation and by complex component and subsystem interactions are ignored to a large extent, as long as they don't reach alarm levels.

In order to implement tools for FDD, usually simplified models based on first principles and heuristic knowledge are used. This is due to the fact that developing detailed physical models is expensive and rarely practical. Extensive literature can be found related to FDD for HVAC and refrigeration (HVAC&R). However, few commercial FDD products for HVAC&R exist today. Those that do exist are usually highly specialised to a few very specific types of components, and not highly automated. In the past two decades, different methodologies have been proposed for FDD at both component and system levels of building HVAC and on-site power generation systems.



With measured physical parameters, FDD based on rules or quantitative models have been developed for different HVAC systems and components. Detection and diagnosis of simultaneous faults have been demonstrated for selected fault groups of roof top air conditioning units. FDD with system-level energy tracking and load monitoring has been explored to isolate major energy end-use problems. Tools with manual and automated data processing capabilities have been developed for specific HVAC subsystems by different parties. Most of these tools require manual processing and analysis of data while a few provide automated diagnosis to some extent. Information from a Building Energy Management System (BEMS) can be imported into these tools for diagnosis.

Rule-based methods can be effective in simple cases. Faults related to schedules, occupancy and daylighting potential can be detected and diagnosed through simple rules with real time data from BEMS. Lighting electrical load profiles were used to detect improper lighting operation. Recently, lighting control has received escalating attention in the building automation industry, with the objective of combining interoperability between HVAC and lighting systems to yield efficient energy management.

Identifying the specific sources and root causes of energy waste in particular buildings can be challenging, largely because energy flows are invisible and because of the diversity of potential problems. A crucial barrier is the lack of data or information at sufficient detail (due to lack of measurement systems or difficulty in acquiring such data) to isolate abnormal changes in load conditions or anomalous equipment operations. Moreover, even if problems are identified, it can be difficult to prioritise a set of corrective actions because it can require comparison of performance among diverse functional elements of a building. Similarly, establishing limits of performance mean a quantification of how much energy is being wasted relative to a physical optimum, constraint, or design intent, and identification of the factors limiting waste reduction is a challenge.

Fault-adaptive control (FAC)

System-level or operational faults in building HVAC systems, user behaviour diverging from the expected use patterns of the buildings, and varying weather conditions can have significant impact on the desired and expected building energy performance and user comfort. Improperly configured HVAC systems such as air dampers and fans may result in higher air intake in air handling units which can increase the need for cooling and thus energy consumption. On the other hand, equipment faults (such as failing actuators or sensors) or deviation in the user behaviour from the expected one may result to building control systems delivering set-points that do not correspond to the current conditions of the building.

Fault-adaptive control (FAC) or fault-tolerant control (FTC) is an emerging technological area, studying the adaptation of control algorithms to faulty operating conditions of a system in order to maintain variations in the performance of the systems, due to the fault within an acceptable range from the desired system behaviour.

Fault accommodation deals with the adaptation of the controller parameters to the actual fault, while control reconfiguration includes the selection of new control configuration to bring system outputs close to the desired performance that is captured from a simulation reference model of the building or to the operational strategies generated by the Optimal Operational Plan Generator. The key enabler is the integration between fault-detection and diagnostics and control algorithms: the FDD algorithm diagnoses and isolates the fault and provides the information to an intermediate reconfiguration layer, which adapts the control parameters or structure to minimise the degradation between the real performance of the system that results from the fault and the desired one.

Maintenance techniques

In industry, maintenance strategies have evolved from breakdown maintenance, to preventive maintenance, then to Condition-Based Maintenance (CBM) and towards predictive maintenance. Breakdown maintenance is the oldest and most common maintenance and repair strategy, and the basic form of maintenance, where maintenance actions are taken only after a system failure. This strategy is known as "fix it when it breaks". In the 50s, the concept of preventive maintenance was developed in order to prevent failure in critical process. In this maintenance strategy, periodic intervals for machine inspections and maintenance are defined regardless of the machine's health condition.

Condition-based maintenance strategy was the next step. Its objective is to monitor system health, based on condition measurements that do not interrupt normal facilities operation. The use of this strategy enables the



performance of maintenance actions at the right time. CBM is a decision-making strategy where the decision to perform maintenance is reached by observing the "condition" of the system and/or its components.

Predictive maintenance programmes have long been implemented by the manufacturing industry. These programmes use diverse techniques (e.g., vibration monitoring, thermography, tribology) to obtain the actual operating condition of critical plant systems, and schedule all maintenance activities as needed, based on this actual data. The aim is to provide the data required in order to ensure the maximum interval between repairs and minimise the number and cost of unscheduled outages created by machine-train failures.

Despite the implementation of these advanced maintenance practices by the manufacturing industry, their adoption by the building sector still remains the exception. Most of the building operators operate in a reactive mode, that the maintenance in buildings is closer to the breakdown maintenance rather than the other more advanced practices.

Decision support tools for building design and retrofitting

The field of decision support tools for building energy design is a recent research topic. Today, with strong energy performance objectives, the question of building retrofitting occurs more often, and the decision has become a more difficult process, with regard to potential benefits, available technologies, occupant requirements, etc.

Aimed at facilitating the buildings' new construction or retrofitting process, a relevant number of decision support methodologies have appeared. These methods often lead to more or less-detailed energy calculations based on real or estimated building parameters and other additional context inputs. Other simplified methods are more focused on estimating initial energy consumption and splitting over a given period (e.g. a year) for main uses (heating and cooling, lighting, etc.).

Rapid advances in data collection and storage technology have enabled organisations to accumulate vast amounts of data. However, extracting useful information has proven extremely challenging. Often, traditional data analysis tools and techniques cannot be used because of the massive size of a data set. Data mining techniques aiming at extracting relevant information that might otherwise remain unknown can make a difference on this field. By analysing large quantities of data, previously unknown and interesting patterns can be identified, such as groups of data records (cluster analysis), unusual records and dependencies.

It is important to establish appropriate monitoring procedures to assess progress against targets and set indicators. A clear performance monitoring mechanism must be applied throughout construction work, to ensure the

sustainability targets are met. Post Occupancy Evaluation (POE) can be incorporated into construction contracts, together with a clear indication of sanctions for non-compliance with designed performance requirements. Mechanisms should be established to assess suppliers' performance in terms of innovation and sustainability.

Detailed energy monitoring was being carried out to evaluate the renovation measures in an innovative renovation of a 1960s office in Weiz, Austria. Before procurement took place, a comprehensive study of the building was conducted to develop a detailed and ambitious energy concept. The building was expected to have a reduction of about 80% in the energy demand for heating and annual CO₂-equivalent emissions per m². Procurement was carried out in two phases: planning and design services, and construction work and building services.

6.2. WHOLE LIFE COSTING

Whole Life Costing (WLC) can be a key enabler of more sustainable approaches to construction. The establishment of joint project teams with both the procuring and operating departments will help to identify the potential in-use costs. Having staff appropriately trained or employing WLC experts within procurement team can mean that a suitable model can be identified for WLC/LCC at the project planning stage, to cover total construction cost, annual operation cost, annual maintenance cost, annual occupier staff cost, and end-of-life cost.

An example of whole life costing for a swimming pool is given from Olhão, Portugal. In an effort to diminish their dependency on fossil fuels and in consideration of whole life costing (WLC), the municipality developed a plan to install renewable energy equipment in its buildings. They recognised that they needed external help to support procurement, and identified a local government agency who managed the procurement process by using WLC to compare the real cost of competing bids. The CO₂ emissions were reduced, and the payback time was estimated to be six years.

Another example illustrates integrating WLC into strategic partnerships by DSTL in the UK. A strategic partnership was set up for 15 years, aimed at providing and supporting new and refurbished laboratory and office accommodation. A model was prepared to illustrate likely future expenditure required for both buildings, structured according to the headings of ISO 15686 (whole life costing). The facilities management provider was able to show the client that, with the new buildings, they were planning to invest during their operation and maintenance stages.

6.3. REAL-TIME MONITORING

In Otaniemi Green Campus in Finland, 100 pilot buildings are monitored at a building level, and 10 pilot buildings at a device level. Data collection is obtained from over 10,000 data points, hourly energy data from 100 buildings, and indoor environmental data from over 3,000 sensors. Real-time electricity data is obtained from over 30 sub-meters, and real-time reading from over 6,000 building automation data points. Monitoring helps to optimise the management of the facilities, with achieved energy savings typically between 15% and 20%.

6.4. ENERGY MANAGEMENT CONTRACTING

Energy management means wiser buying and using of energy. It covers a wide range of services from energy-efficiency improvement to remote control, supervision and reporting of energy consumption, as well as versatile energy market services. Energy market services focus on saving time and money for the client.

Energy reporting, cost reporting and alerting services can be monitored. Remote reading together with quality controls guarantee that the data are always reliable and up-to-date. Correctly functioning building services technologies (including air conditioning, heating, etc.) achieve savings of 10% to 30% in energy costs, while providing more detailed information about other options to further reduce energy use. Experts can use this information to provide suggestions for improving the efficiency of energy consumption, and inform clients about their options in terms of climate control or building automation systems. Remote management improves user comfort and provides substantial savings in space heating and hot water consumption. When energy efficiency is in order, the value of the property also increases.

LeaseGreen designed and engineered an energy efficiency project for a Citymarket retail shopping centre in Malmi, Helsinki. In the project, the automation system was upgraded, and air circulation and a considerable part of the lighting was modernised to LED technology. The estimated life cycle savings from these investments is estimated at approximately €300,000. Energy efficiency offers a great opportunity to save in the retail sector, as shopping centres consume a lot of energy. New technologies can reduce energy consumption by 10% to 30%, with fewer malfunctions and easier service operations. The property owners can also use their energy efficiency achievements in their marketing.

An example of partnering to develop renewable energy is given from Agucadoura, Portugal. The district entered into a partnership with a commercial developer of renewable energy supplies. The district contributed 50% of the investment costs for the installation of photovoltaic and thermal solar panels. The pay-back period was 8 years, and the surplus electricity is being sold to the national utility company for a period of 15 years.

Another example of energy performance contract (EPC) can be seen in social housing in Emilia Romagna, Italy. A pilot site consisting of 13 public dwellings was built in 1981, located in a quarter that needed complete renovation to improve both comfort and energy efficiency. The EPC was awarded to an ESCo (Energy Services Company) through a competitive dialogue process. The final 12-year contract included a guarantee of 35% energy savings per year, providing an immediate 7% reduction in tenants' annual energy bills.

In Berlin, Germany, buildings were bundled for EPCs. Different buildings were bundled into so-called 'building pools,' each covering different types and standards, with more than 1,300 buildings covered in total. The savings achieved varied across pools from 15% to 35%. The contracts were awarded through a negotiated procedure. The contractors are responsible for the cost of refurbishment, operations, maintenance, inspection, systems management, and continuous optimisation.

In Rotterdam, the Netherlands, EPC was applied for swimming pools. The city set a target of achieving a 50% reduction in CO₂ emissions by 2025. As a pilot initiative in 2010, an EPC covering nine swimming pools was tendered based on actual energy savings delivered. The 10-year EPC contract included responsibility for maintenance and operation, and was awarded through a competitive dialogue process. The winning contractor guaranteed annual energy savings of 34%, with any savings beyond this to be shared by the city and the contractor.

Low-energy day care centres were procured through EPC in Porvoo, Finland. The contract was made between the city as the building owner, a finance company to provide the funding, and the service provider responsible for design, construction, and maintenance for the following 20 years. Energy demand was ultimately set at 40% lower than the original goal established by the city, and will be monitored annually. Another sustainability requirement was sufficient flexibility for alterations if needs changed.

7. Calling for Tenders

Project procurement for both professional services and construction works is in principle fairly straightforward. The project owner develops a project procurement strategy to identify a delivery model. The owner, either private or public (or a mix of the two as for a public-private partnership (PPP) concessionaire) then defines the procurement process, and the contract or contract package that formalises delivery.

The selection, evaluation, and performance of suppliers for engineering, architecture, urban planning, information technology, and similar services are of fundamental importance for sustainable procurement. However, today's rapidly evolving frameworks to address urgent global challenges mean that the successful procurement of sustainable construction works depends increasingly upon ensuring a coherent and integrated treatment of difficult-to-specify, cross-cutting **“horizontal” performance criteria** (as opposed to descriptive or prescriptive criteria).

As for their classic counterparts (e.g. maximum values for emissions owing to the contractor's on-site operations), horizontal criteria used for evaluating tenders must be cross-referenced in the contract's specification or provisions (FIDIC 1999). Coherency between tender criteria, tender and contract specifications and contract conditions is therefore essential for sustainable construction.

Thus, while a successful call for tenders for construction works depends upon ensuring the quality of all aspects of a project's professional services and physical methods, this section entitled “Call for Tenders” focuses upon the sustainable procurement of the construction works, either buildings and infrastructure, up to the award of contract.

The outputs in question are generated by key components of the overall procurement system, namely:

1. the project **procurement strategy**;
2. the project **delivery system**;
3. the **procurement process** that implements how the project will be tendered; and
4. the translation of decisions into **contractual obligations**.

It is these key components that need consideration.

In addition to the integration of outputs dealing with performance, tenderer selection and tender evaluation, other aspects of the procurement system should be reviewed in terms of their relevance for sustainable construction. These include:

- the project owner's capacity and resources;
- the relevance of information provided by the owner;
- the relevance of the overall procurement system;
- the methods used for delivery;
- the monitoring and measurement of impacts; and
- the adequacy of commissioning and post-construction activities.

7.1. THE PROJECT PROCUREMENT STRATEGY

Incorporating sustainability in a project procurement strategy requires considerations beyond traditional “best value for money” that “...generate benefits not only for the organisation, but also for the environment, society and the economy” where “.... purchasing reflects broader goals linked to resource efficiency, climate change, social responsibility and economic resilience, for example.” (ICLEI 2018).



The strategy must ensure that construction truly contributes to a region's sustainable development goals by considering "the interface with the neighbourhood scale (e.g. distributed energy systems) and infrastructure including public transport...." while taking into account usability and adaptability in the long term." Moreover, buildings "have a long service life during which they should meet the changing needs of their changing users, changing owners, and a changing climate. In addition, society controls the built environment through regulations, which are also changing because of, for example, increasing environmental concerns and climate change." (ICLEI 2018)

Public owners are subject to supra-national and national procurement strategies and policies. However, the corresponding best-practice guidance is sparse (e.g. the lack of any reference to sustainable development in procurement policy frameworks in Africa) (PPOA 2009; SADC 2016).

National procurement strategies developed by European Union (EU) pre-accession states e.g. Kosovo (PPRC 2017) in response to the EU's public procurement strategy (EC 2017a) offer good examples of how central government can rationalise policies for SPP. In a few cases (e.g. DEFRA 2011), sustainable procurement action plans are developed as an annex to a national procurement strategy. This approach is akin to that discussed below for contracts: the underlying and well-developed approach for a national strategy (or a project contract) is adjusted to handle sustainability.

However, central government normally focuses on guiding public "contracting authorities and entities" (Government Offices of Sweden 2017), where the most structured approach is based on a standard for all designated public organisations (National Treasury 2017).

Equivalents to national public procurement strategies that include sustainability requirements exist for the private sector. These are generally published by industry or professional associations (e.g. CIPS 2017) and may or may not be based on generic sector guides (FIDIC 2004).

Best-practice guidance for public-sector procurement strategies at the project level that incorporate sustainability considerations is more widely available. It often arises out of a central government mandate to regulate lower levels of government (Victoria State Government 2015; Ministry of Business, Innovation & Employment 2015; Scottish Government 2016). Public institutions spanning virtually every sector are also active (e.g. World Bank 2016).

7.2. DELIVERY SYSTEMS

Having developed a procurement strategy, the project owner should be in a position to identify a project delivery system, the form of contract, the procurement process, and the management of project tendering and award of contract.

Every delivery system (see Section 4) has characteristics that suit different conditions and circumstances. Each needs to be examined to identify the system, a hybrid system or a package of systems that best aligns with the project profile and delivers the best value for money and sustainability (so-called “beyond value for money” outcomes) in maximising contributions to the purposes of sustainability (ISO 2016).

Checklists to help identify delivery systems for public-sector projects are widely available (e.g. Ministry of Business, Innovation & Employment 2015; Department of Infrastructure, Regional Development and Cities 2018) but often little is said about how to incorporate innovative sustainable solutions. EU procurement rules (EU 2014a) are an important exception. They classify delivery systems in terms of the capacity to establish technical specifications (important for specifying contractual obligations – see below) and the need to adapt readily available solutions or adopt innovative solutions. For public procurement, the latter is a key issue that may require a specific delivery system which allows a specific procurement procedure (e.g. prior negotiation) so that supply risk accompanying the use of a complex, innovative solution with severe legal and financial restrictions can be negotiated prior to incorporation in a contract.

This focus on supply chain issues in sustainable procurement is a growing trend. South Africa’s infrastructure procurement standard (National Treasury 2017) focuses almost entirely on supply chain management, as do the World Bank sustainable procurement guidelines (World Bank 2016) which classify delivery models in terms of supply risk factors. Indeed, a new international standard (ISO 2017) outlines how to integrate sustainability into existing delivery systems⁹.

Interaction and collaboration

Interaction and collaboration via structured interviews and/or workshops are used increasingly with traditional delivery systems to help align the project requirements. There are also specific contractual issues that benefit greatly from interaction (e.g. minimisation of contingency sums to cover unforeseeable risk; integrated project teams using information technology).

In contrast with traditional competitive delivery systems, PPPs and alliancing arrangements formalise interaction and collaboration to a greater or lesser extent. Incentives are in principle contractually bound and formally aligned between the parties. But this is often questionable, especially for alliance contracts.

In the case of PPPs, the owner decides upon an appropriate regulatory context and suppliers select the most innovative and sustainable solutions and methods. PPPs are increasingly supported by an extensive list of tools to verify their applicability and to support their implementation, including checklists (World Bank & OECD 2015; Australian Government 2008).

Given the increasing acceptance of PPP procurement, a standard for so-called third generation PPPs for countries that have not hitherto “enjoyed the benefits of PPP models” is being prepared (UNECE 2017). Priorities are a) the incorporation of “people first” principles for adequate financial reporting and to support the Sustainable Development Goals so that PPP delivery can be used more widely (UNECE 2016); and b) an impact assessment methodology for what will be mainly performance-based specifications.

Contract conditions are the basis for both “user-pay” and “public sector pay” PPP models, so the “people first” principle requires the ambitious proposal to disclose contract information using as output criteria key performance indicators that include, for example, engagement with stakeholders (UNECE 2017).

⁹ It does not recommend ways to change the models themselves and is therefore limited in its capacity to address sustainable construction.

Applicability

Applicability requirements constrain public project owners as to how they procure sustainable construction. They must respect price thresholds (e.g. EC 2016), demonstrate that procurement procedures effectively support the selected delivery system, and comply with government or agency requirements. More constraining and more difficult to change are the effects of multilateral bilateral agreements between countries regulating market access (e.g. Tanzania's public procurement is subject to nine multilateral agreements).

7.3. PROCUREMENT PROCESS

The selected procurement process complements the delivery system and form of contract. It should aim to identify a preferred tenderer that has the attributes required to deliver the construction works. To illustrate the steps taken, in starting the process owners need to determine:

- a) whether they will request expressions of interest, quotations or proposals or issue a call for tenders;
- b) whether they will use an open tender or selective tender process;
- c) whether the procurement will be single- or multi-stage; and
- d) how to structure tender evaluation criteria.

The procurement process, particularly for commonly-used delivery systems, is often regulated for public owners in some jurisdictions (e.g. there are standardised processes with strict timeframes and communication and probity protocols (EU 2014b)). Implementing these requirements follows well-established procedures in both the public and private sectors (FIDIC 2011): tender offers are solicited in terms of a set of procedures and based on the selected procurement strategy and delivery system, then tenders are evaluated and awarded in terms of defined criteria.

For public procurement, competitive tendering (using most often the open, selective, negotiated, or competitive dialogue methods (FIDIC 2011) should be standard (OECD 2015). Documentation, in proportion to the project, should provide the specification and the conditions of contract and binding information about tenderer prequalification (if any), tenderer selection criteria, tender evaluation criteria, pre-announced award of contract criteria, and whether the criteria support secondary policy objectives or include non-pecuniary criteria.

Non-pecuniary criteria use for example the "value for money" price-quality ratio model that assigns values to sub-criteria to allow weighting against each other and against the price to give the most economically advantageous tender (EU 2014b). Some authorities include other types of criteria (e.g. preferences (CIDB 2008). Others use different scoring schemes (e.g. mandatory criteria for lowest price awards; weighted criteria for highest score awards (Government of British Columbia 2018)) or encourage the use of different performance levels such as the European Union's comprehensive "better/best" relative to core "good practice" criteria (EC 2013) for infrastructure, or the newer "common", "comparative", "optimum" Level(s) framework (EC 2017b) for sustainable buildings which uses mandated standards (EU 2010; REHVA 2017) for sub-criteria.

7.4. FORMS OF CONTRACT

Project owners will have decided the form of contract to use for the delivery method with the successful contractor, as well as the process to procure the construction works in the relevant jurisdiction (in line with government purchasing requirements in the case of public owners).

The project procurement strategy will also have recommended opportunities for bundling multiple projects into a single contract (e.g. where this is likely to deliver efficiencies at a programme level), and for unbundling projects into smaller parcels (e.g. where there are only a few potential contractors capable of delivering a project and/or to promote the involvement of smaller contractors). The relative merits of bundling or unbundling to enhance contributions to the purposes of sustainability have not been assessed.

For public contracts, applicability and selection requirements are once more a consideration. The selected form

of contract must be suitable for the project (including the nature of the work, risk profile and anticipated timeframe for delivery) and for the selected delivery system. In some jurisdictions, regulation restricts the forms of contract that public owners can use for each type of delivery system, especially for commonly-used methods.

Great care is sometimes needed. Performance-based contracts are often cited as an option for sustainable procurement; however, in the US for example, payment arrangements specified in the tender dossier cannot be changed to performance-based payments post-tender through contract modification.

Contracts have a relatively narrow scope of action compared to legal frameworks and similar instruments, especially with regard to sustainability. They nevertheless play an important role in the procurement of sustainable construction, because they formalise both the project strategy, decisions taken during the procurement process, and the outcome of the call for tenders.

Views are divided as to the value of construction contracts, especially for relatively small projects. Widely accepted however, is the view that the purpose of a contract is not just to capture the parties' obligations in terms of time, cost, and scope of works, but also to set out the obligations for unforeseeable events in order to reduce the risk of a dispute.

A substantial contract that deals with a wide variety of matters regardless of the value or complexity of a construction project is therefore the norm for larger building projects and for infrastructure projects, especially if sustainability is an important consideration. The contract in all cases will aim to:

- ensure high quality, cost-effective outcomes by specifying performance and quality criteria, and appropriate apportioning of risk between the parties;
- incentivise the contractor or a design-build team to perform;
- facilitate collaborative working; and
- satisfy value-for-money considerations where appropriate.

The handling of the sustainability requirements is crucial. US government agency guidelines stress, for example, that the outcome of a procurement process is compromised if sustainability requirements are not enforced contractually (DoE 2012).



Private parties are generally not limited in what to include in commercial contracts. However, this does not mean that any provision will be enforceable under law. Enforceability will largely depend on the way requirements are connected to the subject matter of a contract. Requirements must expressly specify a quantity, tangible quality, or a manufacturing procedure, each with an obligation or target that can be measured objectively and a meaningful contractual sanction, if any, where there is any failure to fulfil the obligation or achieve the target.

In the absence of these features, the risk is that the unclear or ill-defined specification or obligation may not be legally enforceable, since legal proceedings might establish something different to what was anticipated. Parties are therefore unwilling to sign up to contract provisions where the basis for establishing a required outcome is questionable.

Indeed, construction industry surveys show overwhelming support for the principle that only when there is certainty that an event is possible can a measurable target serve as a requirement that is legally enforceable and subject to sanctions, if any. The result is that sustainability provisions generally take the form of precise technical requirements or a general contractual obligation to comply with specific and detailed performance requirements, preferably set out in supporting contract documents rather than in the contract conditions.

Following court rulings, some governments, notably the EU (EU 2014b), have arrived at similar conclusions for public contracts. EU contracting authorities may now consider incorporating sustainability provisions and specifications in all type of construction contracts, provided they are linked to the subject matter of the contract at any point in the life cycle of the works. It is now possible to specify targeted recruitment plans (CIFNI 2017), concession contracts that take environmental considerations into account (EU 2014b), and public contracts that include not only direct monetary expenses but also external environmental costs based on factors such as carbon emissions and footprints. These factors need to be derived from “objectively verifiable and non-discriminatory criteria, accessible to all interested parties ...that can be provided with reasonable effort by normally diligent economic operators” (EU 2014b). The degree to which criteria developed on the basis of, say the new CEN/ISO standards (REHVA 2017), meets this test will probably be challenged in court.

Alternatives to standards-based criteria are criteria derived from building codes, certification systems and labels (EU 2014a) proposed by both the public and private sectors for buildings and infrastructure (GIB 2017). There is no standard in this area as to whether they provide objective performance criteria, only suggestions for their use: relevant details must be included in the contract documents; criteria must link to specified objectives; measurements must be objective; criteria must truly address the causes of targeted sustainability issues.

Standard forms of contract

The most appropriate form of contract to formalise the arrangement between the project owner and suppliers for delivery of the project may be an off-the-shelf standard form, a modified standard form, or a bespoke contract developed for a specific project.

Sustainability considerations arise in private contracts in order to fill the regulatory gap left by governments failing to reach agreement on how to address sustainability. Given the risk of credible enforcement, private parties often rely on the wide variety of standard-form contracts which anticipate to a large degree how courts will apply contract provisions. Public authorities often adopt these forms, especially for construction projects tendered using international competitive bidding (FIDIC 2010).

Sustainability considerations

Sustainability is ideally an integral part of a project and not a separate consideration, where the contract may not need to make a specific reference to sustainability. However, terms related to sustainability are at present not generally implied. Relying on an implied term therefore raises questions as to applicability, so for sustainability requirements it is wiser to use express sustainability provisions in contract documents. A sustainability requirement or obligation must therefore normally be stated in a contract specification or in another document that is referred to in a contract document and incorporated accordingly in the contract. However, the situation is evolving, at least for public contracts (e.g. passive solar performance is a “functional objective” that does not need “special treatment” in contracts (DoE 2012)).

Over time the situation may change such that it may be unnecessary to include specific sustainability criteria in contract provisions because sustainability should be the normal consideration. The consensus today is that this situation may never arise, at least for construction works, since sustainability requirements, engineering solutions, materials, and construction methods will evolve significantly.

Provision or specification

In law, an express contract provision is seen as superior to the specification of a requirement in the contract documentation if the provision is a fundamental term as opposed to a warranty because this provides for, in the event of a breach, a stronger remedy such as the ability to terminate the contract.

The way this general premise is implemented to address sustainable construction varies considerably. Some regional governments affirm that the most effective way of delivering sustainable procurement objectives is to set out sustainability requirements in the usual contract document that specifies the owner's requirements (UK 2016).

On the other hand, some new standard forms for relatively small building projects annex an Exhibit, a "single document that sets forth roles and responsibilities for each project participant as they relate to unique elements of sustainable design and construction" (AIA 2017). A dedicated annex is possibly offered because private owners seek clear-cut evidence that sustainability has been incorporated into the design and construction of a built asset.

Others adopt an intermediate approach by meshing contract clauses dealing with the management and/or performance of the contract with detailed requirements specified elsewhere in the contract documents (if standard forms are used the clauses are incorporated as special conditions) (EC 2014). Guidance for social housing contracts (Crown Commercial Service 2015; Victoria State Government 2015) and other practices (e.g. EU 2014b) suggest that this type of "supporting" sustainability clause should cover provisions for the monitoring, reporting and performance review of impacts, in addition to references to measurable performance indicators or impact measures in specifications.

Performance or functional requirements

Specifying contractual performance requirements is clearly necessary for procurement processes where it is known what is wanted but not necessarily how requirements are to be satisfied. Specification in these cases, for example, a design-build procurement, provides a legal requirement to perform but not necessarily for a set price.

The use of contractual performance requirements can be extended to wherever the outcome to be achieved can be precisely stated as specified criteria, and there is an enforceable legal framework. This is the case for sustainable construction provided sustainability measures and targets based on, for example, standard criteria (REHVA 2017) which provide specific performance requirements. However, performance criteria are generally not used when setting mandatory contractual requirements other than minimum specifications to ensure conformity to requirements (EU 2014b) or adequacy for "strategic critical" high risk/high cost projects (World Bank 2016). It is for this reason that today most standard forms of contract do not include standard clauses that support horizontal performance criteria.

General requirements

Standard forms of contract clearly cannot cover specific sustainability issues in a coherent and legally binding way for all of the many different types of construction projects. Considerable flexibility is needed through specification, possibly supported by special provisions.

Established standard forms nevertheless include many provisions that support sustainability and ensure that sustainability can be implemented. For example, major works contracts include provisions that relate directly to sustainability in dealing with 10 overarching objectives, 10 supply chain activities and nine issues that should be considered jointly by the parties to a contract (FIDIC 2017; JCT 2016).

As time passes, standard forms will take up sustainability-related requirements and obligations that today are generally handled using specification, accompanied in some cases by special provisions. Issues related to the

standard of reasonable skill and care will be questioned, as will: the effect of climate change on latent conditions (conditions that cannot be foreseen by an experienced contractor); the ability to foresee changes to building codes and limitations to fitness for purpose obligations; requirements for a contractor's sustainability report and plan; affordable horizontal performance criteria; incentives encouraging the use of life-cycle criteria.

In conclusion, much effort will continue to be spent on establishing credible and measurable sustainability criteria that can be used to procure sustainable projects responding to specified enforceable, legally binding requirements. The challenge is to ensure that sufficient and timely progress is made so that tender procedures and contract conditions remain robust, yet able to respond to major sustainability needs.

8. Case Studies

These case studies from around the world showcase the sustainable procurement and construction of buildings from different perspectives.

8.1 SUSTAINABLE LOW-COST HOUSING FOR INDIGENOUS COMMUNITIES IN AUSTRALIA¹⁰

This case study is about low-cost sustainable housing for indigenous communities on a remote, isolated island in a tropical climate. The procurement consisted of bidding for building modules that the home owners could use in their design. A sustainability consultant, Dr. Steve Burroughs, was hired to choose the contractor and professional services. The two-year post-construction report showed that environmentally sustainable housing can be constructed cost-effectively and can meet the social and cultural needs of indigenous people.

Scope and objectives

In Nguuu on Bathurst Island (Northern Territory, Australia), four new homes were built. The community is remote, isolated, and situated in a tropical climate. The homes were designed and constructed using materials and technologies with environmental sustainability, energy efficiency, affordability, and cultural and social requirements in mind. The project was intended to draw upon innovations in professional practice, new tools, methodologies, technologies, and interdisciplinary working relationships in order to increase the relevance of professional practice to the pressing needs of housing for the Tiwi Islands. The goal of the housing project was to illustrate how to improve access for low-income communities to appropriate housing technology and business enterprise opportunities.

Client

Indigenous families by Indigenous Business Affairs (IBA), a government agency.

Procurement framework

The tender process for the homes involved asking building companies to tender costs for each of a series of housing modules with different sleeping and living area configurations, and also modules with different floors, decks, and roofs. This was to allow prospective home owners to fit together a design of their choice. Construction of the homes involved affordable housing techniques including: a simplified modular design reducing waste and allowing elements to be configured in different layouts according to owner choice and circumstance, the use of timber as a less expensive construction product than competing materials (timber is also lighter than competing materials such as prefabricated concrete panels and steel frames and therefore easier and less expensive to transport into remote regions), less equipment is required to assemble the structures in a timber home, and compact and efficient designs are available with a number of alternatives for adaptable design and future extensions depending on housing requirements.

Partner selection

A major consideration in partner selection was the systematic development of training for the builders and trainees engaged in the planning, implementation and monitoring of housing and environmental improvement and community development activities for low-income families of the Tiwi Islands. The services were provided through a tender process using both preferred and open-type tender procedures.

SBC features

The design and features of the homes were decided via a collaborative process involving input from Indigenous groups, potential occupants, and IBA design/construction experts. The initial design constraints included the following: the desired floor plan; occupant comfort in terms of heat and ventilation; a remote site with limited utility connections; minimisation of energy costs (thermal and electrical); minimisation of environmental impact at all stages of the building life cycle; reduction of operational and maintenance requirements; and ease of construction. The houses use building materials with low embodied energy. Preference was given to materials

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and fixtures that require little or no maintenance. Preference was also given to low-impact building materials and finishes, reducing volatile organic compounds, contributing to a healthier indoor environment. The homes were constructed primarily of timber (sourced from sustainable pine forests), treated to resist termites and mould. The use of wood in construction in remote locations not only saved on building costs and reduced building lead times, but is also a sustainable resource.

Performance measurement

One of the approaches used by the project to reduce energy consumption in remote housing was to identify cost-effective solutions using computer-simulation and modelling approaches. Through trial and error over the last ten years, it has been shown that this approach reduces energy consumption, saves money, and provides a human living environment. based on Human Sustainability requirements of the new Australian Resilience Measuring Scheme (ARMS) under development for application in remote Australia.

A two-year post-construction review of the performance of the houses was carried out, based on a detailed, multi-item assessment. This included the performance and appropriateness of the following aspects: procurement methodology, house design and construction process, final house design form, structural integrity of the buildings, construction materials, exterior finishes, thermal characteristics and ventilation control, environmental performance, cultural suitability of the homes and home-owner satisfaction.

The findings are wide-ranging, with a large number of positive outcomes, and some issues that have arisen. Positive outcomes include a housing procurement system that minimised risk and maximised benefit, the success of environmental design features including high sloping ceilings, natural ventilation, and passive solar elements, cyclone-rated building strength, simplicity, ease of construction, use of termite and moisture resistant timber, culturally-appropriate layout and features, building to the original budget and high levels of interest from the indigenous community.

Problems since completion relate mainly to the need for education of home-owners about the features, maintenance, and use of their homes. Possible improvements to the design include adjustments to solar gain by changing window glazing, but this needs to be confirmed through empirical testing of modelled results.

The post-construction assessment of homes at Nguuu showed that environmentally sustainable housing can be constructed cost-effectively and can meet the social and cultural needs of indigenous people. The findings of the review provided information for IBA's future indigenous housing projects in Australia.

Innovation aspects

The houses constructed in Nguuu (see Figure 6, 7 and 8) are simplified versions of, and follow the environmental principles used in, a demonstration home constructed on the island. Features of the houses include: orientation of house axis according to solar factors; a compact thermal envelope (low surface-to-volume ratio); passive solar heating; natural cooling and ventilation; and solar hot water. Glazing has a low-emissivity coating, and most of the window area is on the north side. North-facing windows are sized for winter heating, with roof overhangs to reduce solar radiation in summer. A security mesh system overlays the windows and reduces solar heat gain by 50-60%. The natural ventilation (in the form of opening windows) is designed to be the primary cooling system (drawing 2). The windows are sized and located for cross-flows and stack effects, with upper windows along the high spine of the house releasing warm air while cooler air enters from lower windows. The main goal of insulation in tropical regions is to reduce solar gain heat during the day. Insulation in the ceiling space comprises fibreglass batts rated at 5R, in the external walls comprises 0.5 R insulation foil, and in the internal walls comprises insulation foil and 5R batts. The houses meet the building code requirements for energy star rating. No concrete was used in the construction of the homes. The footing system consist of steel driven triangle pipes providing bearing capacity for the homes and 3 tonnes of uplift for each mega-anchor rendering the home cyclone category 5 (300K + winds).



Figure 6: Two designs (Picture provided by Dr Steve Burroughs)

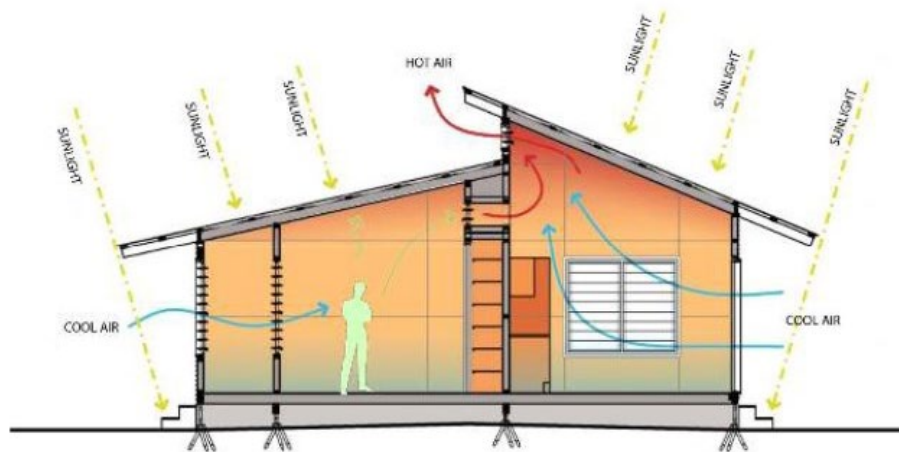


Figure 7: Ventilation system (Picture provided by Dr Steve Burroughs)



Figure 8: North elevation (Picture provided by Dr Steve Burroughs)

Lessons learned

Innovation in procurement and construction systems has been identified by AHURI (2008) as a key element in successful Indigenous housing projects. The implementation of the particular procurement strategy and methodology used for housing delivery has been favourably reviewed by Martel et al. (2011). It should be stressed that the IBA housing project described here involved constructing houses for private ownership by indigenous people and not for social (i.e., public, subsidised rental) housing. Therefore, the procurement system differed from social housing procurement systems and differentially influenced various aspects of the project including goals, construction materials, technologies, and costs.

The Nguui case study highlights the construction materials and technologies required for sustainability, energy efficiency, and affordable owner-occupier housing with particular respect to remote Indigenous communities in Australia. The study shows that sustainable buildings in remote areas can be constructed in a cost-effective manner. It is hoped that the design and construction systems used for the Nguui houses will inform more effective practice regarding the planning, design, construction, and management of Indigenous housing in the country's remote regions. This project has helped IBA to better understand the performance of the design process, construction materials and methods, and procurement methodology used. It also brings to attention the importance of the durability and maintenance of indigenous homes. The information is proving useful as IBA is introducing their home building programme into other Australian remote communities.

8.2. NEW ENERGY-EFFICIENT OFFICE IN KENYA¹¹

This case study describes a new office building in Kenya. The procurement followed the traditional design-bid-build contract where the main contractor was chosen using an in-house developed score card, where 15 to 30 points out of 100 were related to sustainability. The energy consumption was reduced from 147 kWh/m²/a to 42,5 kWh/m²/a with the help of daylighting, natural ventilation, green office equipment, centralised cafeteria, elevator reserved for goods, and server room cooling solution, that were explored after the design was completed but before construction started.

Scope and objectives

The project was the design and construction of a new 20 000 m² office building with 16 500 m² of office spaces for 1 200 workers in Nairobi, Kenya. The UN expressed a high-level vision for the Gigiri campus new office facility (NOF) to be climate neutral, though the vision was not specified in measurable terms. The objective was to procure a good building for 1 200 people within an acceptable budget. The building was designed in a way that solar panels could be installed on the roof afterwards.

The project was initiated in 2002 and inaugurated in 2011.



Figure 11: New office facility, Gigiri campus of the UN in Nairobi, Kenya (Drawing by UN, pictures by Pekka Huovila)

¹¹ Supplementary information: Pekka Huovila, pekka.huovila@figbc.fi, tel. +358 40 546 0855

Client

United Nations

Procurement framework

Both the finance and procurement strategy were specified by the UN headquarters in the US. The project delivery system used was the traditional design-bid-build system in which best value for money wins the contract. The warranty period was one year and the United Nations Office at Nairobi (UNON) is in charge of maintaining the building post-construction.

Partner selection

The architect was selected based on invitations where the Statement of Work (SoW) defined the expected qualities. The main contractor was chosen using an in-house developed score card where 15 to 30 points out of 100 were related to sustainability. No certification scheme was applied.

SBC features

Obtaining sustainability information from local products was not possible as the sustainability concept was still very new in Kenya, and no baseline existed. However, energy consumption was reduced from 147 kWh/m²/a to 42,5 kWh/m²/a with the help of daylighting, natural ventilation, green office equipment, centralised cafeteria, elevator reserved for goods, and a server room cooling solution. The design also included a north-south orientation, rainwater harvesting, water saving, recyclable carpets, and environmentally friendly paints. The 6000 m² of solar panels on the roof makes it energy neutral, even energy positive with the estimated payback time of 4 to 7 years for the additional investment costs.

Performance measurement

Energy consumption is monitored. No target was set for indoor conditions.

Innovation aspects

Automated office lighting; server outside in a container without the need for cooling.

Lessons learned

Objectives and sustainability criteria expressed as part of the overall vision should be set quantitatively and early in the process. A lot can still be improved after the design phase, before construction is started.

8.3. NEW PPP OFFICE BUILDING IN SOUTH AFRICA¹²

This case study describes the first Public Private Partnership (PPP) project that had a specific focus on sustainability performance in South Africa. In addition to detailed targets for this new office building, monitoring, evaluation and penalties linked to non-performance were incorporated. The objective was to develop a high-performance green building that provided a model that could be replicated by other government departments. Monitoring indicates that performance exceeds design targets in most areas; about 20% of the building's energy consumption is being generated from renewable sources, 89 kWh/m²/a energy consumption is being achieved, and water consumption is 40% lower than conventional offices.

Scope and objectives

A new 30,654 m² office building for the Department of Environment was developed in Pretoria, South Africa. The Department of the Environment wished to develop a high performance green building that provided a model that could be replicated by other government departments. Development and operation of the building are based on a Public Private Partnership (PPP) model developed by National Treasury. Sustainability performance targets, monitoring and evaluation processes and penalty regimes (if targets were not met) were developed by Gauge and a professional team for the Department. Renewable energy (contributing a minimum of 10% of energy

¹² Supplementary information: Jeremy Gibberd, jeremy@gauge.co.za tel. +27 82 8571318

consumption), energy efficiency (maximum 115/kWh/m²/a) and a range of water, waste and indoor environmental quality targets were set. The building achieved a 6-star Greenstar rating and was closely monitored to ascertain performance in the first year of operation.

Key stakeholders

Client and occupants: Department of Environment. Architect: Boogertman and Partners. Main contractor: Aveng (Grinaker LTA). Equity holders: Kagiso, WipHold and Old Mutual.

Procurement framework

A Public Private Partnership (PPP) model was used to procure the building. The PPP process has been developed for South Africa by the PPP Unit of South Africa's National Treasury. Key to the model is a PPP agreement that defines all aspects of the building's design and operation and is used as the contractual basis between parties. In this project, a thorough process was followed to integrate sustainability performance into the PPP agreement and monitoring and evaluation processes.

Partner selection

The PPP process included an RFP stage and the selection of preferred bidders was made on the basis of intense evaluation of comprehensive bids. Competing bids included financial models, operational targets and detailed designs and specifications, which demonstrated how the RFP requirements would be met. Detailed assessment of the bids by a multi-disciplinary team is used to identify a preferred bidder and to develop, and agree, to a binding PPP agreement.

SBC features

- Mechanism for monitoring the building's performance over the 25-year operational phase
- Detailed energy, water waste, IEQ targets set for operator with penalties for non-performance
- Passive night-time cooling strategy
- Large storm water attenuation ponds
- Indigenous species gardens
- 80% of construction waste either reused on site or recycled
- Help desk available for complaints and occupancy surveys carried out

Performance measurement

Detailed performance measurement has been incorporated into the operation of the building. This includes energy and water consumption sub metering, renewable energy generation metering, solid waste measurement and IEQ monitoring in relation to temperatures, noise, and lighting.

Monitoring indicates that performance exceeds design targets in most areas and about 20 % of the building's energy consumption is being generated from renewable sources, 89 kwh/m²/a energy consumption is being achieved and water consumption is 40 % lower than conventional offices. The building has received a large number of visits from other government departments and new public buildings such as the Department of Communications and the Stats SA building in Pretoria will include green technologies.

Innovation aspects

The building is the first PPP project that had a specific focus on sustainability performance in South Africa. In addition to detailed targets, monitoring and evaluation and penalties linked to non-performance have been incorporated.

Lessons learned

The complexity of the PPP process can be simplified. The PPP process can be used to support effective design for sustainability and operational performance.

8.4. RENOVATION AND EXTENSION OF A SCHOOL IN THE CZECH REPUBLIC¹³

This case study looks at a school building complex in the Czech Republic. The town council wanted the renovation and a new extension to be not only energy efficient and environmentally friendly, but also well integrated into the social life of town and fulfilling the needs of the community. They hired an expert to steer the process of defining the design brief, setting design targets, preparing architectural competition, assisting in the selection of the winner, and helping to steer the project towards construction. The procurement methodology involved all participating groups for the entire duration of the project.

Scope and objectives

An elementary school in Buštěhrad, Central Bohemian Region, Czech Republic was due for renovation. At the same time, due to expected growth in the number of pupils in the coming years, an extension of the existing building complex was needed. The Buštěhrad Town Council wanted the renovation and extension to be not only energy efficient and environmentally friendly, but also well integrated into the social life of town, fulfilling the needs of the community. The Council approached the University Centre for Energy Efficient Buildings of the Czech Technical University in Prague (UCEEB) to steer the process of defining the design brief, setting design targets, preparing the architectural competition, assisting in the selection of the winner, and helping to steer the project towards construction. The project was initiated in January 2015, the architectural competition took place in July 2015, detailed construction documentation in December 2015 and start of construction works was planned for early 2016.

Key stakeholders

Client: Town of Buštěhrad. Occupants: local pupils and teachers. Sustainable procurement steering: University Centre for Energy Efficient Buildings, Czech Technical University in Prague. Architect: ADR s.r.o.

Procurement framework

The project was initiated by the municipality of Buštěhrad and financially supported by the grant of the Ministry of Finance of the Czech Republic. The methodology and project coordination was carried out under the leadership of UCEEB and is linked to the new sustainability assessment scheme SBtoolCZEDU, which is set up for existing and new school buildings in Czech conditions. The core of the methodology is based on (i) involving all participating groups in the whole duration of the project, (ii) architectural competition to find an optimal functional and architectural solution, (iii) strong cooperation among architects, engineers, and builders, (iv) ecological design based on using natural and renewable materials, design for low energy use and the use of renewable energy sources.

Partner selection

The architect was selected based on an architectural competition where a detailed design brief defined the expected qualities. The main contractor was chosen at the end of 2015.



Figure 12: Outcomes of workshops with the youngest pupils. (Pictures provided by Dr. Jan Růžička, CVUT.)

¹³Supplementary information: Dr. Jan Růžička, jan.ruzicka@fsv.cvut.cz, tel. +420 778 433 990



Figure 13: Focus group with teachers in discussion with facilitators.
(Pictures provided by Dr. Jan Růžička, CVUT.)



Figure 14: Final design of renovation and extension by ADR s.r.o. (Pictures provided by Dr. Jan Růžička, CVUT.)

SBC features

The basic technical requirements included in the architectural competition were:

- High quality of indoor environment
- Mitigation of passive solar gain
- Integration of renewable energy sources presented as an educational element
- Efficient control systems integrating RES into renovated technical room
- Recovery of heat from ventilation of classrooms, kitchen, and canteen
- Utilisation of renewable materials for building structures of the school extension
- Utilisation of prefab construction elements so that the main construction process takes place during the two months of summer holidays

The main innovation in the actual project stage was a participative process of design brief definition. The team was working with these main target groups:

- Teachers and school employees – focus group methodology, i.e. structured discussion steered by facilitator and individual interviews with participants.
- Pupils (1-9 class) – survey fit to the age of pupils in classes, workshops in various classes with topic “Our school in two years – if I was an architect” and drafting of future scenarios. In the work has been included a motivation letter for the teachers and detailed instructions on the goals and expected form of outcomes of the workshops.
- Parents of pupils – communication by electronic survey accompanied by a cover letter.
- Contacting local municipal interest associations.

Based on the surveys of the project stakeholders, the design brief was expanded to include requirements for the better connections of buildings and spaces; improved design targets for disabled people; requirements for transportation solutions for pedestrians, parents’ cars, teachers’ cars, supply vans; improved safety and security measures; more spaces for teachers for relaxation and preparation; new requirements on the interconnection of classrooms with the school garden.

Performance measurement

Energy consumption, production from RES and indoor environment are monitored.

Innovation aspects

The participative creation of the design brief was innovative, and sustainability aspects were included from very early in the design stage.

Lessons learned

Technical and environmental objectives can be set quite well by an experienced advisor, but for the improvement of school buildings functions, communications, and equipment of rooms, a detailed discussion with all relevant stakeholders is needed. The sustainability design targets have to be set early in the project planning and design stages as a basic requirement.

8.5. PUBLIC BUILDING RETROFIT IN SPAIN¹⁴

This case study describes the first of 330 public building renovations in Spain aimed at reducing energy consumption and CO₂ emissions. The scope of the project was to perform an integral renovation of the building complex of over 30 000 m². The work carried out included the upgrade of the building envelope, substitution of most of the building services, and the implementation of a new energy management strategy. A major constraint was that the building was meant to remain fully operative throughout the renovation. The project delivery system included design, construction, and energy management in which best value for money wins the contract. The yearly revenues for the consortium depend on the energy saved each year. The length of the contract is 20 years, which can be extended if both parties agree.

Scope and objectives

This project is the first in an ambitious government plan (Energy efficiency and Savings 2008-2011) which aims to renovate 330 public buildings across the country to reduce their energy consumption and CO₂ emissions. The scope of the project was to perform an integral renovation of the building complex, which is over 30 000 m². The work carried out included an upgrade of the building envelope, substitution of most of the building services, and the implementation of a new energy management strategy. It was intended to achieve significant consumption reductions such as 10% less energy use in kWh/person/year, 13% less in CO₂ emissions and an improvement in the building’s energy label (from F to C, according to Spanish energy certification). A major constraint was that the building was meant to remain fully operative for the duration of the renovation.

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Key stakeholders

The consortium awarded with the project included a general contractor, a utilities company, an energy services provider, and an engineering firm. The client is the Spanish government.

Procurement framework

Both the finance and procurement strategy were specified by the Spanish government. The project delivery system included design (taking into account existing constraints) – construction (renovation works) - energy management, in which the best value-for-money tender wins the contract. The yearly revenues for the consortium depend on the energy saved each year. The length of the contract is 20 years, which can be extended if both parties agree.

Partner selection

The consortium combined four partners with high expertise in renovation works, energy management and energy supply. The project was awarded to the consortium with the best price and best technical proposal.

SBC features

A comprehensive solution was conceived and implemented including, among other things, high performance boilers, a co-generation system with an absorption pump, a domotic (automation) system to monitor and control energy consumption, and a programme to educate the building users.

Performance measurement

Energy consumption is monitored. The target is to reduce energy consumption and CO₂ emissions (see above) while keeping conditions comfortable according to Spanish regulation for public buildings.

Innovation aspects

From a public procurement perspective, the concept of design-renovation-management for such large building complexes is a fairly new concept.



Figure 15: Public building, Spain (Picture provided by Carlos Barcena, Dragados)

Lessons learned

There are high risks in this kind of contract which need to be addressed from the beginning. These risks are associated to energy prices, savings forecasts, user behaviour, regulation changes, equipment performance over time, etc. The contract should include a revision mechanism which helps to adapt the revenues fee according to update data inputs. A risk share approach between client and the energy service company is the best approach.

8.6. BUILDING A TEMPORARY OFFICE IN THE NETHERLANDS

This case study portrays circular procurement where a Dutch municipality asked for a temporary office for a period of 20 years in its request for proposals. The winner of the tender came up with a building designed for disassembly, making the new temporary town hall 30% cheaper than two other comparable town halls that were built in the vicinity. They proposed an alternative business model where the products used were retained throughout the life-cycle instead of selling them to consumers. The model fits into the broader trend of extended producer responsibility, integrating services into a product offering.

Scope and objectives

The municipality of Brummen in the Netherlands was in need of a new town hall. The municipality asked for a temporary office for a period of 20 years in its request for proposals. The winner of the tender came up with a building designed for disassembly. The estimated total cost of the building was between EUR 1 million and EUR 5 million, thus making the new temporary town hall 30% cheaper than two other comparable town halls that were built in the vicinity.

Key stakeholders

Client and Occupant: municipality of Brummen. Architect and main contractor: local firms selected by public tender, the winner of which was a Dutch company called Turntoo.

Procurement framework

The procurement considerations included maximum sustainability within the available budget, performance requirements, and making the greatest possible use of knowledge in the market. The award criteria were as follows with price and sustainability each awarded a maximum of 30 points in order to have equal importance: price, design, planning, opportunities/risks, quality management, corporate social responsibility (CSR), and presentation.

Partner selection

The firm that was selected for the design was through public tender based on the criteria mentioned above.

SBC features

The winning bidder, Turntoo, proposed an alternative business model where the products used were retained throughout the life-cycle instead of selling them to the consumer. The model fits into the broader trend of extended producer responsibility, integrating services into a product offering. The new town hall was conceived as a raw materials “depot.” It is a temporary arrangement of construction materials, with all the details of its future use (or second-use phase, or “second life”) are known in detail.

Performance measurement

Energy embedded in the products is retained at the highest possible level because of the innovation features mentioned below. No other targets or performance measurement are mentioned in the case study.

Innovation aspects

The producers retain ownership of the materials and get their profits from the use, rather than the sale, of the products. This provides them with an incentive to make the product as durable and efficient as they possibly can, using the materials as many times as possible prior to being replaced. Upon the end of the building’s life, the producer will disassemble the building. The materials used will re-enter the production loop, reducing the demand for new raw materials (For more information, see Jones et al. 2017, p. 45).

8.7. SOCIAL HOUSING DEVELOPMENT IN SPAIN¹⁵

This case study explains the procurement of 188 dwellings promoted by the Madrid City Council Housing agency EMVS, with the highest energy class A in Spain for low-income tenants. One of the selection criteria for contractors was post-construction service experience or reporting on proposed improvements for the building where sustainable criteria could be included. The architect was selected through a public tender for detailed design and on-site project coordination.

Scope and objectives

The project involved the design and construction of two new social housing developments Barajas 1 & 2, a low-income development of approximately 13 200 m² consisting of 188 flats within four to six-storey building blocks in four different units, plus 30 dwellings in 15 duplex townhouses, including 238 parking spaces and 4 retail units. The apartments include one (38 m²), two (54 m²) and three bedrooms (80 m²). The buildings, promoted by Madrid City Council Housing agency EMVS, were finished in 2012. They have an “A” energy rating (best in class energy efficiency rate in Spain).

Key stakeholders

Client: EMVS. Owners: Low income profile. Architect and main contractor: local firms selected by public tender.

Procurement framework

The procurement strategy was established according to EMVS public tender procedure for both the architect selection and building contractor selection, in two different processes. The building contractor tender needed to meet measurable criteria such as budget offer, as well as non-measurable criteria such as post-construction service experience or reporting on proposed improvements for the building where sustainable criteria could be included. The building contractor had to offer a warranty period of 10 years and a two-year period after completion, during which 5% of payment would be retained to cover faults.

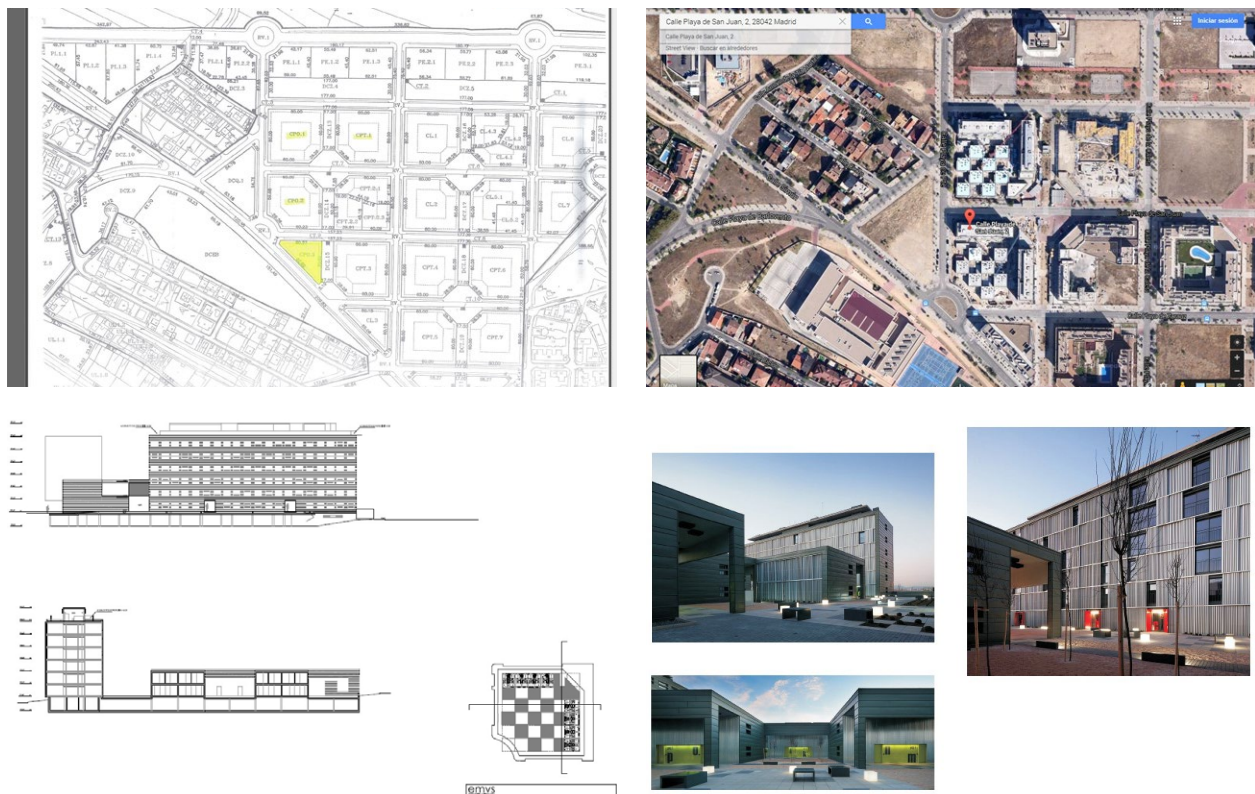


Figure 16: Barajas 1 & 2, Madrid, Spain. (Pictures provided by Almodena Fustera, EMVS)

¹⁵ Supplementary information: Almodena Fustera, fustera@emvs.es

Partner selection

The architect was selected based on public tender (for design, detailed project, on-site coordination). The main contractor was selected based on public tender. Sustainability was not a selection criterion, and no certification scheme was applied.

SBC features

Sustainability information regarding local products is not yet a criterion for tender procedures. Blocks orientation has been taken into account, as well as bioclimatic issues (e.g. cross ventilation).

- Heating and hot water production are centralised for B1 & B2.
- Barajas 1: Total heating volume is 16 160 m³. Central hot water heating is provided by thermal solar panels (36 units, 114 m²) and two gas condensing boilers (2x294 kW). Electrical loads are standard home appliances and lighting, including cooling units with high demand in summer season. Loads in common areas include lighting and elevators. Total installed power is 800 kW.
- Barajas 2: Total heating volume is 17 400 m³. Central hot water heating is provided by thermal solar panels (64 units, 150 m²) and two gas condensing boilers (2x275 kW). Load features are similar to those in Barajas 1. Total installed power is 800 kW.

Performance measurement

Energy consumption is monitored through an energy manager. Targets for indoor conditions are based on CTE national building regulations.

Innovation aspects

Centralisation, as well as the use of solar thermal energy are common features. Bioclimatic criteria for building design are also part of EMVS's sustainability strategy.

9. Recommendations¹⁶

1. Consider the whole life cycle of the building to be procured

Buildings have a long service life. Maintainability of the building as well as repairing and replacing their components during operation have a big impact in sustainability. Even in procurement, management of the building in use should already be considered.

2. Set sustainability targets and document them

Sustainable buildings don't often materialise by chance. Define your sustainability objectives in concrete terms and follow their achievement in every phase. If the design solutions are changed during the process, make sure you know if the original targets are still met. You can always change the targets, but this should be done knowingly. Social aspects are part of sustainability.

3. Define financing strategy and choose the contractual mode

The supply chain can also be part of financing and they may make profitable business in proposing solutions or maintaining the building in a sustainable way. It should be for the benefit of the building owner and users as well. Choose a delivery system where market experience and local skills can be best exploited. Various collaborative procurement modes have proved successful in complicated projects when risks can be shared before starting the work.

4. Select a sustainable supply team

Apply sustainability criteria when choosing the designers, contractors, and manufacturers. Design costs are only a fraction of the business costs in a building to be procured. Study the references and the capability of the team, their knowledge and experience in using sustainable tools and practices.

5. Assess conformity throughout the process

Verify meeting the objectives in every phase in the process from setting the objectives. Commissioning does not only take place during hand over, but already during earlier stages in design and construction, even in target setting. Keep on tracking the performance after the building is occupied.

6. Continuous improvement through monitoring, reporting, and verifying

Learn from good practices in earlier projects. Measure the achieved performance and apply their baseline as a benchmark for new projects and maintenance practices. Network with other practitioners, exchange experiences and improve practices. If the targets are not met, study what didn't go as planned and learn from deficiencies.

7. Keep the process inclusive and transparent

Beware of imported specifications from other market areas that may exclude local suppliers for tendering or negotiating the contract. Learn from other guidelines but adapt them to meet the local needs, skills, and traditions. Establish procedures empowering local employment including all genders and the youth.

8. Influence in user behaviour

Sustainable buildings may be occupied unsustainably. Set metering so that users see the impacts of their behaviour, e.g. savings through energy efficiency. Apply contracts where users benefit from sustainable behaviour. Establish benchmarks of good practice and provide incentives for conscious occupants.

9. Leave space for innovation in the process

Keep the process performance-based when possible. This makes it possible for market forces to propose sustainable solutions that the client may not have thought of. Make sure the assessment criteria are clearly defined so that you have control over delivery and the responsibilities remain traceable.

¹⁶Adapted from presentation <http://kms.energyefficiencycentre.org/web-resource/introduction-sustainable-procurement-principles-building-efficiencywebinar-1907201>

10. Support collaboration

Suppliers providing sustainable solutions that are profitable for the customer should also gain from higher performance. In energy performance contracts, the service providers make their profit in improving the energy efficiency of buildings, while the owners save money at the same time. Build trust within the network. One actor can't make big changes alone, but the team may achieve it together if they share common objectives and want to achieve them.

Next Steps

Hopefully, this guide has provided enough inspiration and knowledge to review, and if necessary, change procurement procedures. As outlined above, a number of economic, social, and environmental benefits arise from building sustainable buildings. Procurement officers have one of the most important roles to play in ensuring the success of a sustainable building through the careful selection and contracting of the building design and construction team. The options outlined above can serve as important tools and drivers for change in the built environment. However, not all organisations may be able to apply the full range of procurement methods above. Some organisations have policies or laws in place that restrict the type of procurement methods permitted for use. In these cases, we encourage the reader to begin a dialogue with their policy and decision-makers about other procurement options and the potential benefits they hold. Further, the reader can engage their local experts, participate in further training on sustainable buildings and procurement, and work collaboratively with colleagues to affect significant change.

For additional information and resources to further the discussion and build understanding of sustainable public procurement (including webinars, trainings, and additional publications), or to share additional case studies and experiences, please visit www.oneplanetnetwork.org. Information on the Sustainable Buildings and Construction Programme can be found at www.oneplanetnetwork.org/sustainable-buildings-and-construction, and information on the Sustainable Public Procurement Programme can be found at www.oneplanetnetwork.org/sustainable-public-procurement.

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