Part A Designing the building

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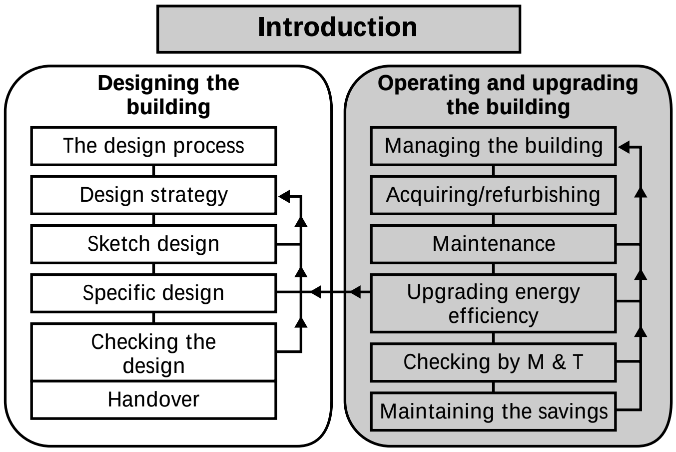

2 The design process

2.0 General
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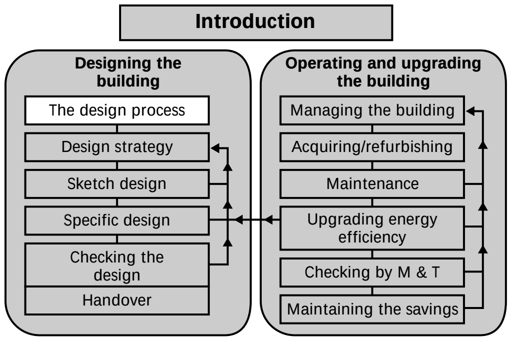

This section shows how and when energy efficiency can be included in the design process, in line with the principles given at the front of this Guide. Designers should seek a balance between overall cost and good design practice, while meeting the occupier's business needs. Energy efficiency plays a central part in any good design and is exceptional in being cost-effective over the life cycle of the building.

2.0 General

The process of energy efficient design should always include:

- identifying user requirements
- designing to meet these requirements with minimal energy use
- establishing an integrated design team with a brief and contract that promotes energy efficiency
- setting energy targets at an early stage and designing within them
- designing for manageability, maintainability, operability and flexibility
- checking that the final design meets the targets.

Success depends on understanding the interactions between people, building fabric and services, as shown in Figure 2.1[1]. This integrated design approach requires the successful collaboration of client, project manager, architect, engineer and quantity surveyor at the early conceptual stage of the project[2,3,4].

The most significant influence in energy efficiency is often the way the building is used by the management and occupants. Hence, the principles of energy efficiency at the front of this guide place great emphasis on management issues. Activity, hours of occupancy, control settings etc. all vary enormously and represent the greatest unknown at the design stage. Designers need to take account of this variability and promote better building management through improved design. A good management regime, which is responsive to the needs of the occupants and fully in control of the building, can have a major effect on energy consumption.

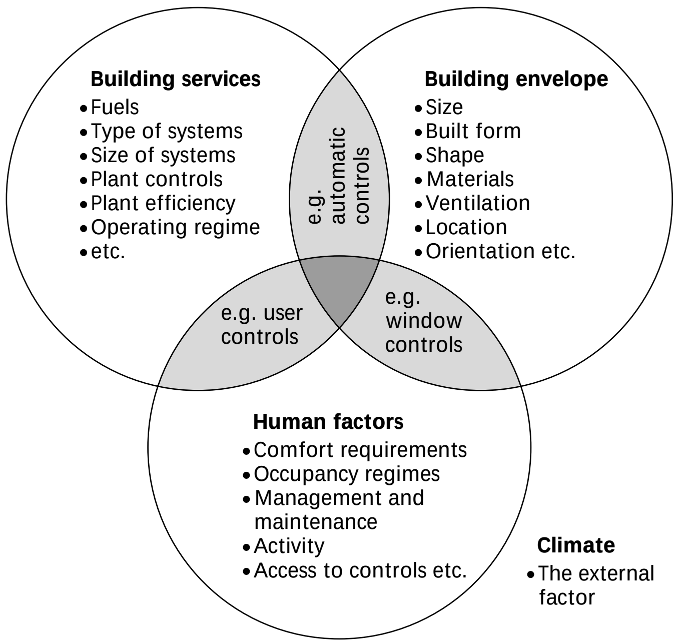

Figure 2.1 Key factors that influence energy consumption

The integration of building envelope, services and 'human factors' should be covered in the brief and is a key part of the sketch design stage. The early design concept needs to be tested against the client's criteria, which normally include cost, quality of the internal environment and compliance with energy and environmental targets, e.g. by using *BREEAM*[5]. If it does not meet the criteria, the design team should review the design concept or the client's requirements. This iterative process is essential in reaching an effective energy efficient design.

Generally, owner-occupiers will be more interested in low running costs than will speculative developers. However,

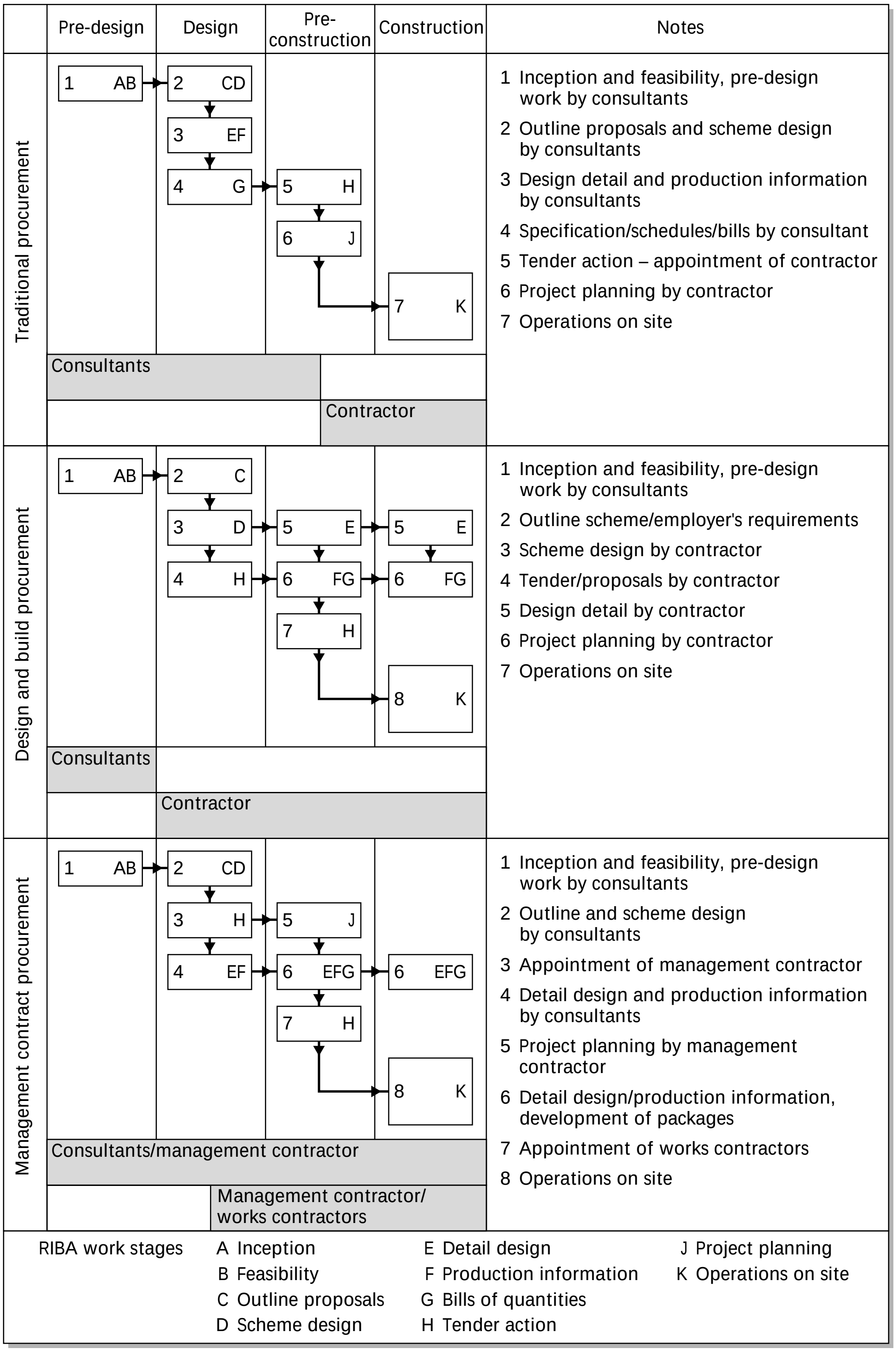

Figure 2.2 Common methods of building procurement

developers should recognise that buildings that are energy efficient and therefore have low running costs can attract a premium in the market place and are increasingly likely to do so in the future.

2.1 Stages in the design process

Standard plans of work[6] usually need to be modified to meet the requirements of the building users and the contract being undertaken. In particular, provision should be made to review energy issues throughout the plan to ensure that the energy concepts are not gradually diluted or dropped. The plan should also formalise the responsibility for energy and ensure that energy issues are well communicated during the design process[7,8]. A speculative development that will be fitted out by the occupant will need a different approach to energy efficiency than a bespoke building for an owner-occupier. Examples of these different approaches are shown in Figure 2.2.

The plan of work should identify specific points at which the design team will report on how the design meets the client's brief. Table 2.1 illustrates this in relation to RIBA *Plan of Work*[6] stages.

Table 2.1 Reporting on energy efficient design

Work stages	Details to be reported by the design team	Energy efficiency considerations
(A) Inception	Prepare general outline of requirements Plan future action	Establishment of energy and environmental objectives, criteria and targets Establish an appropriate team
(B) Feasibility	Appraisal and recommendations of how project will proceed Show it is feasible, functionally, technically and financially	Ensure good communication within the design team with a goodplan of work Develop a clear design strategy that integrates fabric, services and human factors
(C) Outline proposals	The brief as far as has been developed Explanation of major design decisions and definition of user requirements Firm estimate with outline cost plan	Site considerations Building form and arrangement on site Outline servicing and energy strategy, e.g. naturally ventilated, mechanically ventilated, air-conditioned, daylighting etc. Selection of fuel/energy types
(D) Scheme design	Statement of the fully developed brief Explanation of scheme outline specification Cost plan Future timetable	Design of fenestration taking into account the ramifications on heating, cooling fans and pumps, and lighting energy Selection of building thermal characteristics; levels of insulation and thermal response Decisions on main plant arrangements and control strategies, and main vertical and horizontal routes for services Decisions made on lighting and daylighting systems, and their control
(E/F) Detail design/production information	Preparation of the production drawings, specifications, schedules etc	Detailed plant/system design Detailed design of system controls Provisions for monitoring system condition and energy use Commissioning requirements and acceptance procedures Building/system management requirements and documentation

There will be a significant level of overlap between the individual activities taking place throughout the design process. This is illustrated in Figure 2.3, taken from *BS 8207*[9] which highlights the timing of critical design decisions that influence the energy performance. *BS 8207* also makes recommendations for achieving energy efficient performance in buildings and hence provides a framework that can be applied to new designs or refurbishment. It should be noted that the environmental objectives of reducing carbon dioxide emissions and environmental pollution are particularly important for design decisions 1, 4, 6, 10 and 16 in Figure 2.3.

2.2 The design team

The multi-disciplinary design team should be appointed at inception, prior to the conceptual stage of the design, and comprise typically an architect, building services engineer, quantity surveyor, structural engineer and client representatives. Each member should consider the energy implications of each design decision; the design team should also obtain feedback from the client during the design process.

The design team should:

— make the client aware of the implications that decisions have on life cycle costs

— provide an energy efficient design that takes account of energy management and maintenance needs

— provide projections of energy performance and running costs

— propose further options for energy efficiency, highlighting the potential benefits

— produce good documentation which makes the design intent clear.

Ideally, all team members should be involved for the entire duration of the project[2]. The client's requirements must be clearly identified and any changes addressed by the team as the project develops, any implications being reviewed with the client, as necessary.

2.3 The energy efficient brief

The energy efficient brief should be no more complex than is appropriate for the type and size of building[2,10]. It should incorporate:

— the client's intentions, requirements and investment criteria

— energy targets

— environmental targets e.g. *BREEAM* credits

— life cycle costs

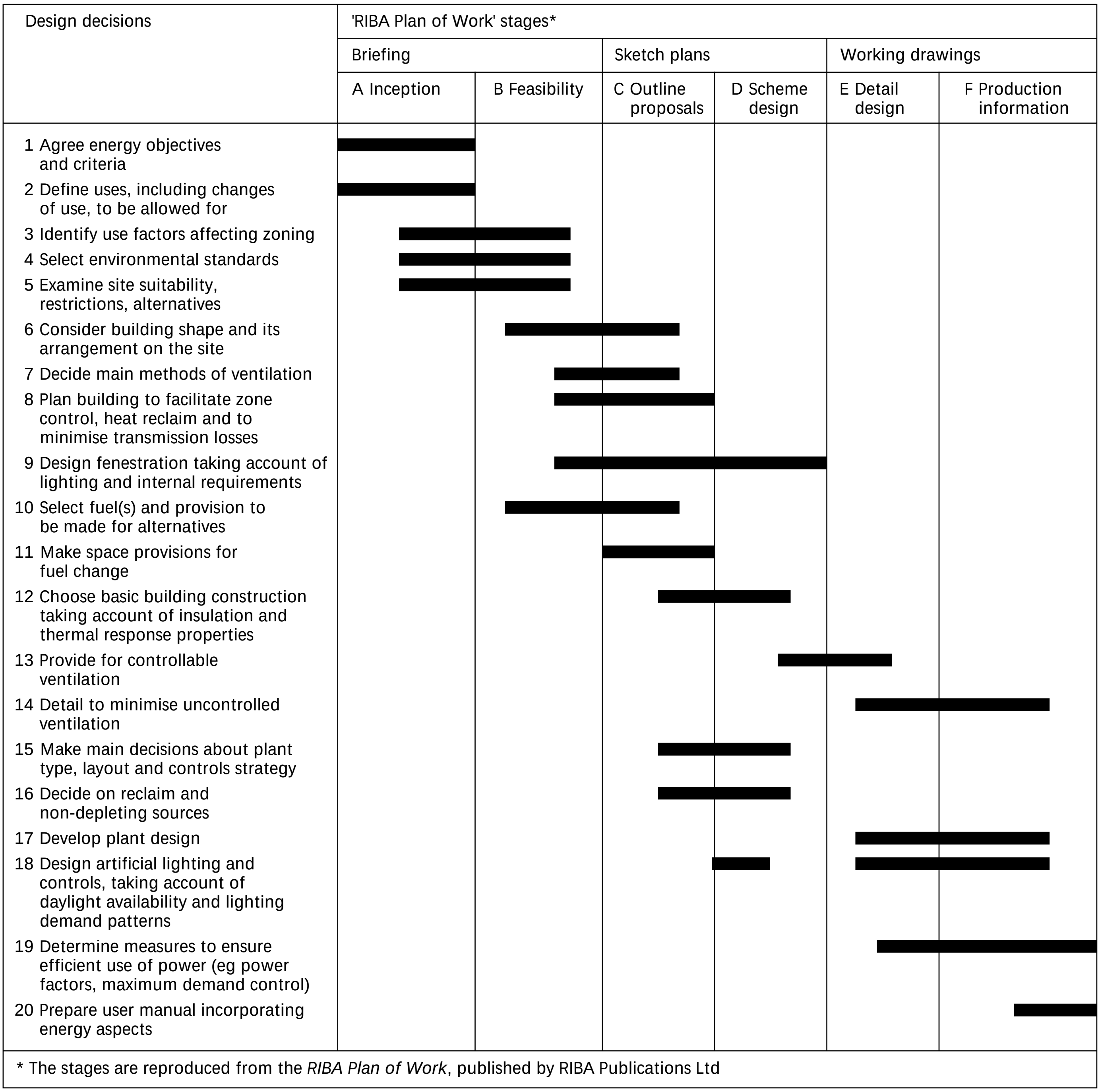

Figure 2.3 Timing of design decisions (reproduced from *BS 8207: Code of practice for energy efficient buildings* by permission of the British Standards Institution and the Royal Institute of British Architects. This extract from *BS 8207: 1995* is reproduced with the permission of BSI under licence no. PD\1998 0963. Complete editions of the standard can be obtained by post from BSI Customer Services, 389 Chiswick High Road, London W4 4AL.)

— the intentions to include energy efficient equipment

— a requirement to undertake integrated design.

Where possible, a range of options should be considered before deciding on the overall design concept. It is possible to meet a particular brief through a number of design solutions and it is important at the briefing stage to establish the aims and objectives of the design to ensure that they are reflected in these solutions.

The energy implications of the internal environment and loads specified in the brief should be explained to the client by the building services engineer. Unrealistic criteria can result in plant being oversized with energy and cost penalties. For example, excessive lighting levels will increase both capital and running costs. Equally, specifying very narrow bands of temperature or humidity is likely to increase energy consumption. This is particularly true if air conditioning is required as this can increase building energy consumption by up to 50%[11]. Humidification and dehumidification should only be specified where absolutely essential.

Internal and external design conditions should be selected in accordance with CIBSE Guide A1: *Environmental criteria for design*[12]. However, designers should agree an acceptable range for the internal environmental standards, as these can have a significant effect on plant sizing and energy consumption. For example, maximum summer indoor temperatures might be selected that typically are not exceeded for 97.5% of the time. Flexible options should also be considered, such as to allow bands of temperature, humidity or ventilation to float across seasons.

Higher air change rates usually mean increased energy consumption, particularly with mechanical ventilation, although heat recovery and 'free' cooling may redress the balance. Areas where smoking is allowed require around four times the ventilation rate per person, so restricting these areas reduces energy consumption and improves the quality of the internal environment.

The level of occupant control can have a very significant impact on the way systems are used and hence on future energy consumption. Occupants' response to their environment is influenced by:

— the quality of the environment

— the perceived level of individual control

— the quality of the management of services and response to complaints

— the desire to be close to a window.

Results from building user surveys[13] show a 'virtuous circle' of characteristics, with responsive and effective management of buildings leading to staff satisfaction, better energy efficiency and improved productivity. Where occupants' tolerance of the internal environment is low, the building is unlikely to function efficiently. This is more likely to be the case in air conditioned buildings as they tend to exclude the external environment.

In essence, this means that buildings that make good use of natural light and ventilation, in which occupants have the opportunity to make local adjustments, often provide more acceptable environments and hence greater energy efficiency.

2.4 The contract

The building design contract should promote energy efficiency by ensuring that all building professionals work together creatively to achieve an integrated and energy efficient design. Energy efficient buildings often require greater professional skill and design input. The team must, therefore, have enough time at an early stage to formulate an integrated sketch design.

To realise energy efficient designs, each stage of a contract needs to be carefully assessed to ensure that the design intent is followed through to actual performance, and the predicted returns realised. Although this can result in an enhanced fee component on a contract, it ensures that the client's brief is addressed.

Fee structures based entirely on the capital cost of the building services may not encourage energy efficiency, which often requires more design input and a lower plant capital cost. Lump sum fees based on the estimated time spent are therefore becoming more common, allowing greater scope for energy efficient design.

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