



# INTEGRATED DESIGN PROCESS GUIDE



# INTRODUCTION

- Integrated Design (ID) is advisable in managing the complex issues arising from planning buildings with high energy- and environmental ambitions.
- Key issues are collaboration in multi-disciplinary teams, discussion and evaluation of multiple design concepts as well as clear goal-setting and systematic monitoring.
- In the early design phases, the opportunities to positively influence building performance are great, while cost and disruptions associated with design changes are very small.

*Front page illustration;*  
Powerhouse office building at Kjørbo, by Snøhetta architects (NO).  
Roof view of solar cells and light shaft with glimpse of winding staircase.

May 2014  
Layout: sander architects, Denmark



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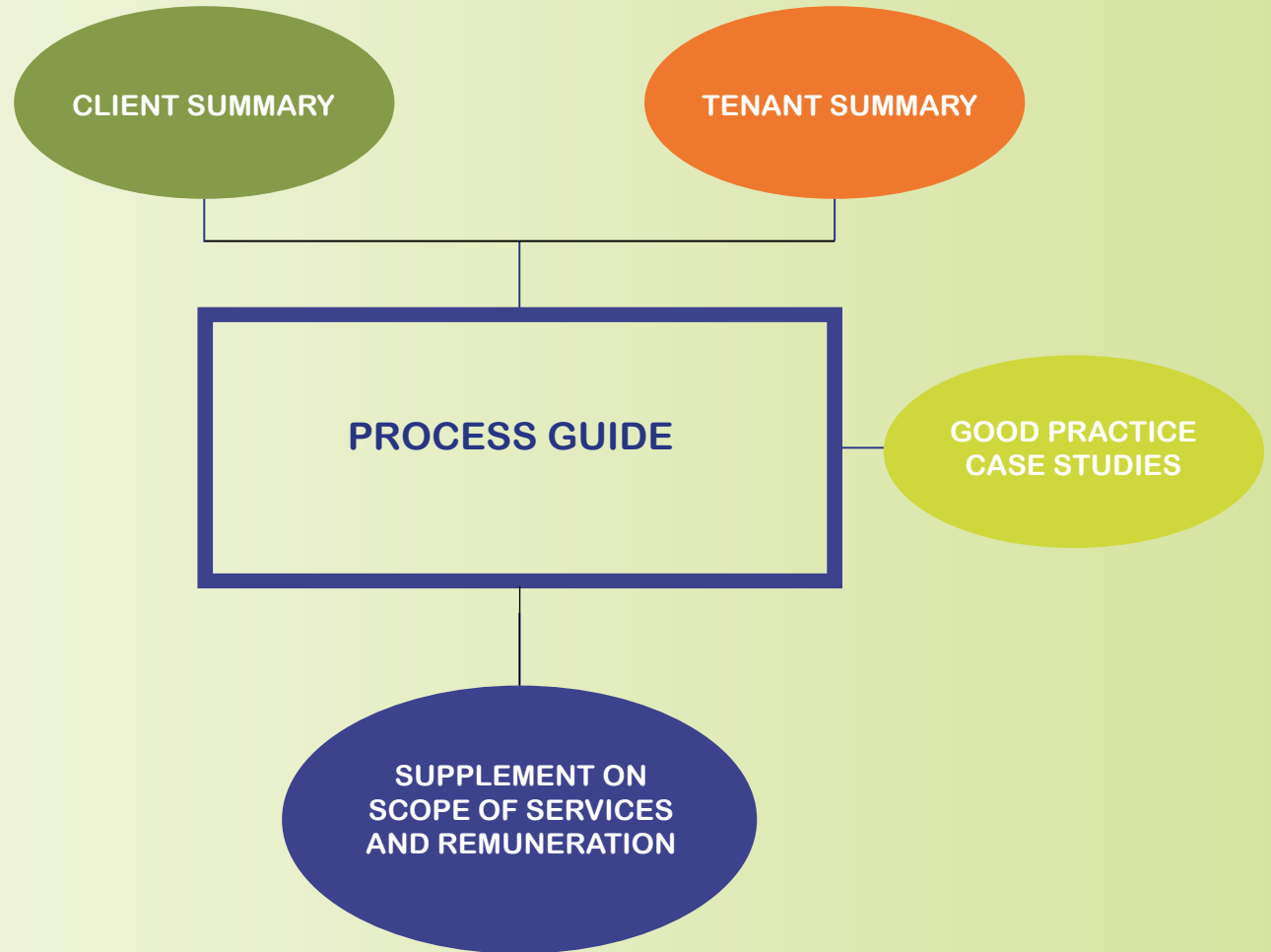
MaTriD

Market Transformation Towards Nearly Zero  
Energy Buildings Through Widespread Use of  
Integrated Energy Design

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# ID TOOL KIT



The ID tool kit is composed of the ID process guide (this document) and supplements.

# PREFACE

The Intelligent Energy Europe (IEE) project MaTrID - Market Transformation Towards Nearly Zero Energy Buildings Through Widespread Use of Integrated Energy Design – aims at supporting the implementation of Nearly Zero-Energy Buildings until 2020 by application of Integrated Design processes. In this context the application of Integrated Design during the building design phase is of particular importance.

Integrated Design (ID) is a valuable approach to reduce the complexity of the design process and facilitates the interactions between the members of the design team. This ID process guide gives a clear step by step explanation about the ID approach, and is one of the core outputs of the MaTrID project.

# FROM IED TO ID

As a starting point, the concept of Integrated Energy Design (IED) has focused on achieving lowest possible operational energy demand through an integrated design process and through integrating energy efficient measures into the early design concepts.

6 In recent years, however, the overall need to reduce Green House Gas (GHG) emissions has increasingly been focused in discussions about building policies: Meeting the EU requirement of nearly zero emission energy buildings (nZEB) in 2020, the target is basically set to reduce energy consumption, but the more overarching target of zero emission buildings means that, in addition to energy reduction, a wider spectrum of environmental topics now needs to be included.

As the current challenge is based on the threats of climate change, the framework for assessment must therefore shift to addressing all impacts that cause GHGs.

Indoor air quality, avoidance of hazardous substances, responsible resource use, bio-diversity and green transport are examples of indicators pursued in environmental assessment schemes such as BREEAM,

LEED or DGNB. Such schemes can help to define the environmental goals and translate the GHG reduction measures into clear and quantifiable targets for building design.

The complexity of these goals and their translated building design targets strongly supports the need for integrated design and a better cross disciplinary approach.

Furthermore, the approach of ID is relevant not only for buildings with high environmental ambitions, but for many other construction challenges. There are a growing number of new demands that must be integrated into the design of modern buildings, and the contemporary design process commonly involves an increasing range of professionals and specialists. Clear goal-setting and communication between stakeholders are generally and increasingly understood to be important to avoid failures and sub-optimal outcomes.

For these reasons, from now the more general term Integrated Design (ID) will henceforth be used, replacing the previous Integrated Energy Design (IED).





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Figure 1;  
Kvamsstykket passive house kindergarden, Tromsø, Norway.  
Architects and landscape; Arkitekturverkstedet/ Asplan Viak, Oslo  
and Tromsø. Photos: Asplan Viak

# WHY INTEGRATED DESIGN?

**Integrated Design** is not a new notion or concept. It is instead the next stage of the evolution of best practice as modern design processes move towards greater complexity and more challenging building requirements. The relevance of the concept is based on the well-proven observation that changes and improvements of the design are relatively easy to make at the beginning of the design process, but become increasingly difficult and disruptive as the process unfolds.

Changes or improvements to a building design when foundations are being poured, or even contract documents are in the process of being prepared, are likely to be very costly and extremely disruptive to the process. Additionally, it can be demonstrated that late attempts at improvements are also likely to result in only moderate gains in performance.

Thus, the performance of buildings should be assessed in a lifecycle perspective, both regarding environmental performance (LCA) and costs (LCC). The ID model of collaborative design emphasizes that the very early phases of design need more attention because well informed decisions here will pay off in the rest of the building process, as well as through

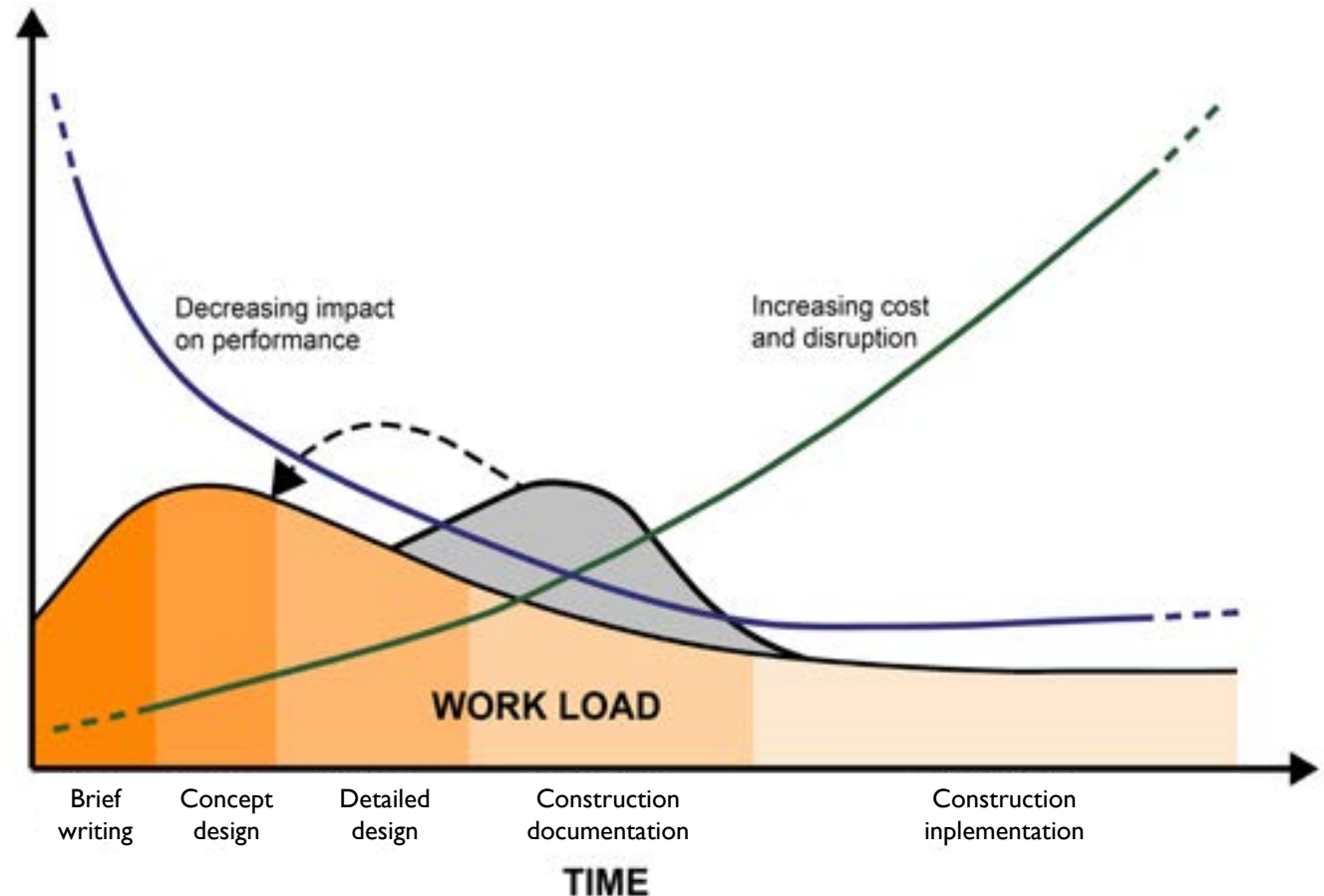


Figure 2; Early design phases offer opportunity for large impact on performance to the lowest costs and disruption. Therefore, a shift of work load and enhancement to the early phases will probably pay off in the lifecycle of the building.



into the lifecycle of the completed building. Well informed planning from the start can allow buildings to reach very low energy use and reduced operating costs at very little extra capital cost, if any.

When considered against the whole life cycle of a building, the running costs are significantly higher than construction and refurbishment costs; thus, it becomes obvious that it is a shortsighted approach to squeeze the first design phase regarding resources. Experience from building projects applying ID shows that the investment costs may be about 5 % higher, but the annual running costs will be reduced by as much as 40-90 %.

Whilst it is recognised that in commercial construction the capital and operational costs are frequently borne by different parties initially, both of these costs are ultimately drivers on the tenants' occupancy costs through rental, service charges or similar mechanisms.

According to a report on the Business Case for Green Buildings, integrated design process will increasingly play a key role in keeping costs down without compromising quality. The design and construction of a green building does not necessarily need to cost more, but ensuring this is dependent on a well understood and communicated overall environmental strategy. An integrated design approach that combines smart, passive design, thermally efficient building skins and effective space planning to reduce energy

demands as a first step, combined with highly efficient systems, provides a cost-effective alternative to bolt-on systems installed on an otherwise under-performing building.

Figure 3; Estimations of increased/ reduced costs connected to ID

TASKS	COSTS	COMMENTS
Concept and Pre-design	5 -10 % more	Based on experience
Detailed engineering	< 5 % more the first projects 5-10% less in the next projects	Based on experience – smoother process caused by more detailed concept design
Building costs	5 – 10 % more	3-6 % for Passive houses
Operational costs	40 – 90 % less	Based on experience
Building faults	10 – 30 % less	Because of better planning and better follow up during construction

In addition to reduced long-term operation and maintenance costs, green buildings are increasingly proven to increase marketability as well as to improve worker productivity and occupant health. And conversely, it is now widely accepted that poor environmental buildings negatively influence building values.

In figure 4, the various benefits of green buildings for developers, owners and tenants are visualized. (WGBC 2013)



Figure 4; The interplay of Green Building benefits for developers, owners and tenants (WGBC 2013)

# Benefits of ID:

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## Higher energy performance

Optimization of building form, orientation and facades is reached through open multidisciplinary discussions and design forums in early project phases, where knowledge about important conditions is exchanged to inform the design of the building.

## Reduced embodied carbon

Optimized design is given priority before advanced technical systems and control mechanisms. The high embodied carbon of HVAC components are thus reduced.

## Optimized indoor climate

The building and technical systems work together in a logical symbiosis in order to achieve sufficient indoor air quality, temperature control and daylight access/ solar protection.

## Lower running costs

Simplified technical systems are more cost efficient, both in terms of investment costs for manufacturing and installation and in terms of running costs and maintenance.

## Reduction of risks and construction defects

Improved planning and coordination at design stage leads to less building faults at construction stage: Thus; less issues for remediation and a reduction in the risk of legal conflict, both equating to cost savings during the construction and post-completion phases.

## More user involvement

Early involvement of users and inclusion of user needs in the design process is extremely likely to improve the following performance of the building in the operation phase, as well as increase user satisfaction.

## Higher value

A high performance building can often achieve higher headline rental costs which can be compensated for by a lower energy bills (or consequentially lower service charges) - a «win-win» situation for tenants and building owner. Sales value of the building will increase based on higher rentals, improved lettability and more 'futureproofing'.

## Green image and exposure of the building

A green image can benefit the building owner or tenant organization.

# Main barriers:

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## Conventional thinking

The building sector has historically often been slow in accepting new ways of working. ID calls for decision processes and design methods that challenge familiar habits and require high communication skills.

Professionals on all sides of the table must fully and openly engage in collaboration and therefore potentially adjust their traditional 'defensive' working habits.

## ID seems to costs too much

Developers traditionally pay more attention to construction costs than lifecycle costs (LCC). However, when energy consumption and maintenance is included in the calculations, it usually supports investments in planning for high performance and robust solutions. Ref fig 3.

## Time constraints in initial design phase

Developers can sometimes fail to understand the value of thoroughly planning, and expect high speed in conceptualizing a building. It can be challenging to convince the developer that the initial phase is crucial, and that giving time for design iterations often pays off in better concepts.

## “Skills tyranny”

As the ID process requires more collaboration between stakeholders who may have diverging goals, conflicts can be accentuated in the design development. It is therefore necessary that all team members do not resort to inflexible positions within their fields of expertise, but rather endeavor to work with a holistic approach and accept alternative possibilities for joint investigation.

# CASE I

## Powerhouse Sandvika, Norway

Rehabilitation of 1980s offices into plus energy buildings 2013-14. Energy for operation, embodied energy and production of renewables will give a positive energy balance over the lifecycle. E.g. glass panels from facades will be reused in the interior. <http://powerhouse.no/en/kjorbo-eng/>



Developer; Entra  
Architects; Snøhetta  
Energy consultants and tenants; Asplan Viak



«All of this is known technology. The secret is the way in which we worked and put things together. Because nobody can build a plus-house alone. The innovation lies in the collaboration»  
Project leader, Skanska (main contractor).





# WHAT IS ID?

Figure 5; Simple model studies of building concepts can be efficient ways of visualizing pros and cons of different alternatives.  
Photo; NTNU/ Ole Tolstad

**Integrated design** is an approach that considers the design process as well as the physical solutions with the overall goal to optimize buildings as whole systems throughout the lifecycle.

13 Initially, in order to identify the highest achievable building design performance, alternative building and technical solutions should be developed and discussed by an integrated, multidisciplinary team. ID emphasizes a decision process based on informed choices with regard to the project goals, and on systematic evaluation of design proposals. This approach for building design parallels the principles of environmental management referred to in the international ISO 14001 standards. Here, identifying and prioritizing goals, and developing an evaluation plan with milestones for follow-up, are central issues.

Secondly, the ID approach should intrinsically favour achieving technical requirements with design solutions rather than additional building systems. Indoor air quality, visual comfort and need for heating and cooling are to a great extent influenced by the passive qualities of the building, including geometry and material properties. In an integrated design process, high indoor comfort and low energy consumption



should be achieved through passive design measures, and thereafter the building should be supplemented with as few efficient technical systems as possible to obtain the current specifications. The further it is possible to push the architectural shape, facades and

material choice in the direction of utilizing free solar energy, daylight and natural air flows for ventilation, the less energy supply will be needed in the operational phase of the building



# Definition

ID is defined as a combination of;

1. Collaboration between stakeholders (client, architect and other consultants, and as soon as possible, users) from early on in the design process.
2. In achieving high energy/ environmental ambitions, the implementation of integrated architectural solutions or passive qualities are prioritized before active systems.

14 This guide is mainly an explanation referring to point 1; How to ensure an integrated design process. Although the process guidelines need to be adaptable to different situations, there are some common structural features that can be identified. In figure 6, the main steps of the ID process is visualized.

The need and scope for integrated design depends on the project complexity, type of contract and the level of ambitions. Goal setting is emphasized as an important step overall because the design process will depend on the goals and to what extent they are understood as a joint mission for the design team.

A “design process facilitator” can be appointed to take a lead of the ID process to facilitate an effective coordination in the project organization. However, the outcome of the project is not necessarily dependent on the involvement of a separate facilitator; the important judgment criterion is rather whether or not the goals are reached.

## The ID process

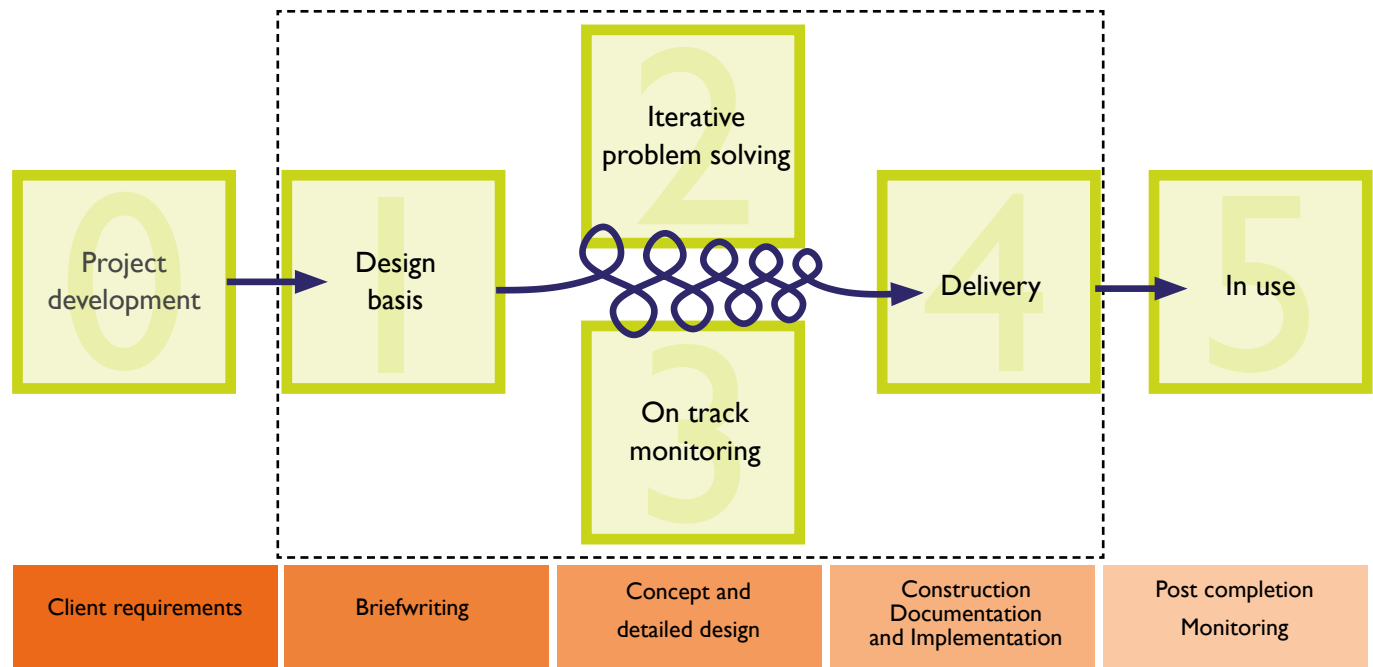


Figure 6: Overview of the ID process. The creative problem solving process (2) runs parallel in time with monitoring the progress according to the goals (3). This is rarely a straightforward process, and the phase should be kept open long enough for all necessary information to be integrated in the design.

# THE ID PROCESS STEP BY STEP

## STEP 0

### PROJECT DEVELOPMENT

#### 0.1 - Discuss project ambitions, and challenge initial Client Presumptions (initial brief).

In the start-up phase with the client, the initial demands should be discussed and challenged towards high ambitions. Goals may include many items, ranging from energy labels, NZEB targets and BREEAM classifications, through to client or tenant occupational needs and preferences.

Attempts should be made to discuss the potential longer-term advantages of a high-level performance to ensure the client can make an informed decision: A presentation of Life Cycle Costs may be an appropriate way of enabling a client to see an enhanced business model beyond a focus on short-term profit.

Examples of questions that may be posed to the client and, as soon as possible, future tenants to help the development of the project brief regarding sustainability issues:

- Does the organization have an environmental policy?
- What image should the building convey?

- What are the requirements with respect to indoor environment (lighting, air quality, temperatures and noise)?
- What are the client's commercial goals, and what are the economic constraints or profit demands (e.g. payback time, investment cost, etc.)?
- What are the client's views on the balance between time, cost and quality?

#### 0.2 – Initiate ID process, preferably utilising partnering contracts.

In the start-up phase, the architect and/or consultants can present the concept of ID. Previous examples from past or demonstration projects can help support these discussions. Note that as the contractual conditions for ID may differ in different countries, the models for integration and associated arguments for ID may be subject to national variations.

Under traditional construction consultant appointments, there are not usually any contract-related incentives for the consultants' performance (such as for exceeding determined energy efficient design parameters). Design fees are typically either a percentage of the total construction budget or a flat rate, commonly derived from time involved or 'going rates' in the marketplace. This approach has the effect of discouraging additional design work, such as improvements to overall building performance, since there is no additional incentive to exceed the minimum requirements of the client brief. Furthermore, as consultants inevitably seek to avoid litigation arising from design oversights or failures, it is not uncommon for significantly oversized systems to be specified, since there is no incentive for saving equipment or energy costs.

Whilst not obligatory to undertaking an Integrated Design approach, ID may be encouraged by using



Figure 7; Lifecycle assessment. Source; Isover

# STEP 1

## DESIGN BASIS

alternative ways of contracting. New models exist for contracts in building projects that focus on co-operation between the team to find the most optimal physical and technical solutions, and a more optimal building process. One such contract model is Partnering, which is a structured management approach to facilitate teamwork across contractual boundaries. Key words are formalized common objectives, agreed problem solving methods and an active search for continuous improvements.

16 A partnering model may include some sort of Performance contracting, where the client pays the design team according to achieved goals. If the building is off target (e.g. regarding energy consumption), the design team or contractor must pay the client a pro-rated penalty (up to a maximum amount). On the other hand, if the building performs better than expected, the client reward the design team or contractor with a pre-agreed bonus. For the purpose of final demonstrability regarding achievement of the preset targets, the goals thus should be very carefully set.

### 1.1 - Select a multi-disciplinary design team, potentially including an ID facilitator, motivated for close cooperation and openness.

The members of the design team should be skilled in their relevant professional issues, but perhaps as importantly they should be genuinely motivated for close collaboration. As further described in step 2.1; communication competence, willingness to cooperate and openness must be required of all team members. Depending on the project complexity and its goals, there may be a need for one or more specialized team member (e.g. ecology, materials, daylight, controls etc.), and it is advisable to define the expectations to the different specialists early in the process. The inclusion of a “design process facilitator” should be considered, especially in cases where the architect and client lack knowledge of collaborative working or where the project has particularly challenging performance goals. This person is recommended to be contracted separately to the client in order to guarantee effective coordination and management of the ID process and to avoid and resolve any problems of goal/interest. Supervision and on-track monitoring throughout the design process should be performed by a facilitator or other person with the authority to challenge both the design team and the client. This facilitator should also be responsible for reporting to the client any variations against the project goals

originally defined. A process facilitator such as a BRE-EAM or LEED Accredited Professional (AP) may be the right option in cases where environmental goals are pursued through an environmental assessment scheme.

### 1.2 - Undertake an analysis of the boundary conditions.

Every building or urban planning project has a set of boundary conditions and contextual issues that will affect the design goals and process. Relevant knowledge should be based on appropriate information from local authorities as well as neighbours.

Examples of issues that should be identified and discussed should include:

#### *Location and site*

- Integration into urban environment (surrounding buildings as well as future buildings), local architecture and surrounding landscape
- Orientation of the site; solar access and wind conditions
- Natural resources on the site or in the close vicinity; solar energy, geothermal energy, sea/lake water, etc.
- Surrounding traffic, noise, and air quality
- Infrastructure – transportation and energy supply (e.g. district heating system) etc.

### Trends and Market

- What is the intended return on investment?
- What are the expected future energy prices and level of interest?
- What are the expected future environmental regulations for buildings (e.g. carbon-taxes, labelling systems, codes, etc.)?
- What are the expected future user demands with respect to environmental performance and building quality?
- What are the expected technological advances that may influence the environmental performance of buildings (e.g. information and communication technologies)?

### 1.3 - Refine the brief and specify the project ambitions, preferably as functional goals.

The often quite broad initial demands of the client should be translated into clear performance targets and design criteria in the final brief. Preferably, the goals should also be prioritized so that it is clear to the design team how to allocate resources. Obviously, the client is a key player in the goal-defining team, and his/ her commitment to supporting measures for high-performance is imperative.

The goals should be functional and not overly specific. For example, it is typically important to create a pleasant and high quality indoor air quality, which would be a desirable goal, whereas setting specific demands on air change rates and or particular technical solutions may be intended to achieve the same outcome, but would be an undesirable goal to set.

In this regard, the client and/or tenant(s) should ensure they understand the need for not setting overly specific finite demands: Functional demands will give more freedom in the design phase, and open up for more flexible solutions that is likely to pay off in the long run. That said, functional goals should be quantitative wherever reasonably possible in order to ease the demonstration that they have been achieved.

In the brief specification phase, sketching up physical solutions should be avoided so that the project does not get tied up to one solution too early.



Figure 8; Location and site define important boundary conditions for a building project:

Photo: Kirsten Sander, sander architects, DK



# STEP 2

## ITERATIVE PROBLEM SOLVING

**2.1 - Facilitate close cooperation between the architect, engineers and relevant experts through co-localization/ workshops.**

18 Close cooperation can be facilitated through the design team cohabiting office space during the process, and/or collaborative workshops where the design issues are discussed in an open-minded way. However, in order to cooperate more efficiently, the architects and engineers may need to adapt their working methods and ways of communication (see separate text box). Communication competence, willingness to cooperate and openness must be required of all team members. (Poel 2002; "A Blueprint for a Kick-off Workshop").

A "kick-off"-workshop at the start of the early design phase is recommended to explain the nature of ID and to support the team spirit. The main objective of the workshop is to create common understanding at the beginning of the design process with regard to the integrated design approach and the importance of cooperative and open attitude towards the other stakeholders. It is a great advantage to share a clear perception of the design task and to agree on a common understanding of the project goals.

## Ways of working

### Traditional planning

Traditionally, architects and engineers have quite different ways of working. The engineer is trained to solve precisely defined distinct problems, and typically works his way analytically and stepwise through the problem-solving process, until a solution is reached. It is common that these problems only have one (or a limited number of) "right" answer. The process is almost linear and the need for developing alternative solutions is often neglected.

The architect, on the other hand, typically starts with a more complex, ill-defined problem and a variety of possible solutions. It is extremely unlikely that there will be one "right" answer. The problem-solving calls for a creative process, characterized by a series of circular movements rather than a linear sequence. This will take him from a preliminary idea based on his individual experience through an iterative analysis of related impacts. Creating the solution and defining the problem are investigated simultaneously.

### ID planning

Building design, and in particular environmental building design with focus on the passive qualities, is dependent on conceptualizing the important design parameters into one building configuration. The shape and layout, façade design and materials together form a synthesis that are intended to resolve the design brief (the "problem"). With the functional aspects of the building program as a point of departure, implementing the technical and environmental aspects in the building fabric in a visually logical and pleasing way is traditionally the responsibility of the architect. At the same time, specific analyses of technical issues need to be carried out simultaneously to ensure that decisions are based on robust data, and this is traditionally the responsibility of the engineer.

### Necessary changes

In order to cooperate more efficiently, the architects and engineers need to adapt their working methods and to change the way they communicate. The architects need to make their conceptual ideas more explicit and explain them to the engineers at important decision-making points. They need to open up for input from the engineers and specialists and to wait for feedback before moving forward. In tandem with this, the engineers have to work in a more dynamic interaction with the architect, simultaneously evaluating and suggesting ideas and solutions as the design evolves. They need to present their ideas and recommendations without using specialist terminologies, figures or diagrams, but rather helping to visualize the consequences of their suggestions on the whole building level.

At the early design feasibility stage, it is recommended that the engineer should use simple "table-tools" to give immediate feed-back to the architect's different outlines, instead of complex tools where the result takes many days to get. As a team, the architect and engineers have to present their proposed solutions and related consequences to the client.



Suggestions to a workshop agenda:

1. Presentation of the overall goals for the building by the developer
2. An introduction to Integrated Design
3. Discussion on how the design team can get the most out of everybody's knowledge and how to cooperate in practice
4. Discussion of the project's main challenges and how to cope with them
5. Decision of important milestones for the projects and how to follow-up

The final task of the workshop should be to make a plan for further work and subsequent future workshops. Issues for further investigation should be identified, along with persons responsible for carrying out the work. This should be implemented in the quality control plan (see 3.2).

Following the kick-off workshop, an initial design workshop should be arranged where the relevant specialists are invited to present short overviews of their issues. In small projects, the kick-off workshop and the design workshop may be merged together. However, before starting the design process and

discuss physical solutions, the design basis for the project should be set (see 1.3). The greater the consensus that the group is able to reach regarding the goals on beforehand, the easier the design task will become.

During the following design process, several smaller and more focused workshops should be arranged between the different professionals. The client should be invited for major decisions. The discussions may identify the need to acquire additional specialized support, who may be invited into the workshops.

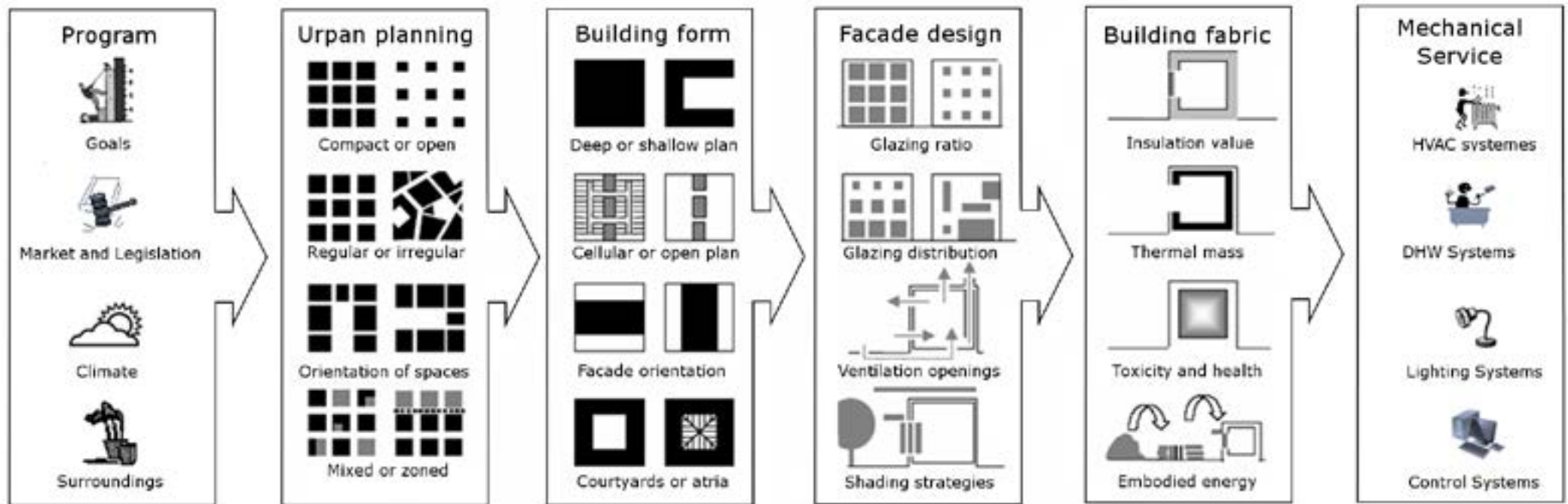
Ideally, the entire design team should be working in a close day-to-day cooperation, facilitated by physical proximity (e.g. project office). However, as this is not always possible in practice, simple ways of co-working such as through e-mailing and desk-top sharing may be relevant in smaller projects and in cases with less stringent time frames.



Figure 9 © www.CartoonStock.com

# Main concerns of environmental design

Source; K. Steemers 2006/ I.Andresen 2009 (www.intendesign.com)



- Urban planning issues (compact vs open structure, energy infrastructure and potentials for renewables, solar access/shading, wind conditions, noise, pollution, traffic planning, ground water/ surface water as well as considerations of ecology, landscape and food production).
- Building form and layout (efficiency of space use, compactness, thermal zoning incl. transitions indoor/ outdoor, daylight access, ventilation strategies, passive heating and cooling, air distribution, flexibility of use and future changes).
- Facade design (glazing area, window size and placement, solar shading, daylighting systems, ventilation openings, heat insulation and avoidance of cold bridges, airtightness layer determination).
- Building fabric (construction system, insulation, resource use and production impacts, durability (technical/ esthetic) and maintainability, thermal mass, hygroscopic mass, indoor air quality/ emissions, waste handling and potentials for recycling).
- Mechanical services (heating, cooling, ventilation and lighting system design strategies, control systems and monitoring).

## 2.2 – Use both creative and analytical techniques in the design process

Design can be defined as an iterative problem solving process that includes identifying challenges, gathering data, clarifying problems, generating ideas and selecting solutions. These steps involve creative as well as critical thinking, and require alternating between

analysing the problem and solving it. The client, as well as the whole design team should be aware that an optimal building design rarely is created in the first sketch. Often many rounds, with frequent setbacks on the way, are necessary.

## 2.3 – Discuss and evaluate multiple concepts

Hold an open discussion on schematic options relative to performance targets and priorities, costs and other implications. Discuss how the different schematic options may be improved with respect to energy performance and other goals, and what other implications this may lead to.

Development of alternative building concepts is usually a part of any design process, and this phase should be kept open long enough that all relevant issues are considered.

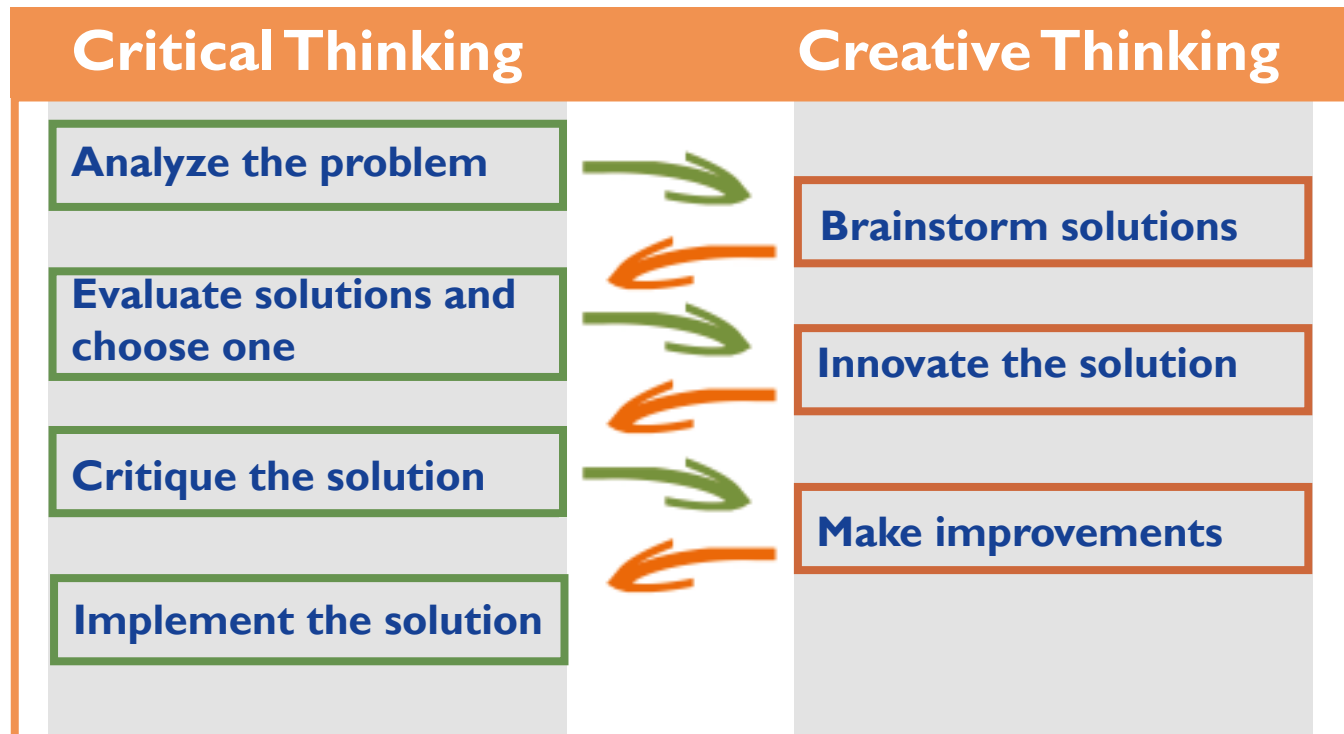


Figure 10; Creative problem solving. Both critical and creative thinking is needed in the design process. Guides and literature on creative problem solving might be useful tools in work-shops as well as in the following design process. See e.g; [www.creativeeducationfoundation.org/our-process/what-is-cps](http://www.creativeeducationfoundation.org/our-process/what-is-cps)

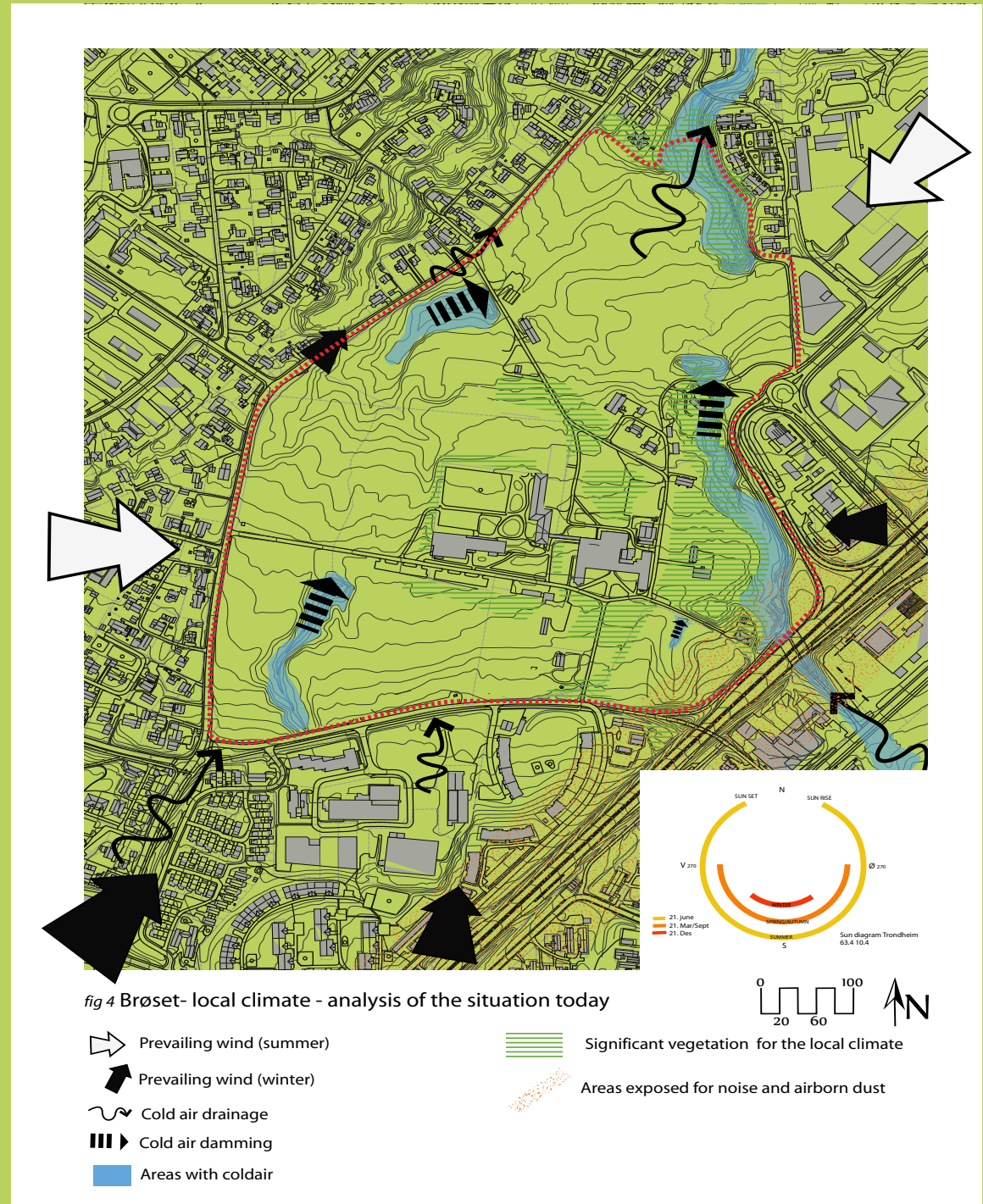
## 2.4 - Finalise optimised design

In the final part of the problem solving process, the client is usually involved in the decision on preferred scheme to progress. The arguments regarding what scheme to choose should be clearly stated, with reference to the original goals.

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Final checks for the goals, such as LCC, should also be performed. If future monitoring of performance is to take place, this should be planned in the subsequent detailing phase.

Figure 11; Local climate analysis at Brøset, Trondheim (Norway). The map shows solar access, summer and winter winds, cold air accumulation, vegetation and areas exposed to traffic noise/pollution. The analysis was performed as part of a briefing for an architectural competition. Source: Asplan Viak.





# STEP 3

## ON TRACK MONITORING

### 3.1 - Use goals/ targets as means of measuring success of design proposals

The goals need to be followed up throughout the design process as well as building phase to ensure that the decisions made are actually implemented in the finished building. It is crucial to have an agreed reference for evaluating the performance of the design. When an environmental assessment scheme such as BREEAM is used, a standardized documentation procedure safeguards the chosen goals. However, using such assessment methods should not dissuade the client and design team from setting and monitoring goals that fall outside the method.

### 3.2 - Make a Quality Control Plan

A Quality Assurance Program describes the overall ambitions for the building, and is a goal orientated version of the Client's brief. It represents what the Client wants, with goals set against each of their requirements. It may also be useful to weight the goals or rank them. It is important that the Quality Assurance Program is deeply rooted in the decision makers of the project, and it should be given the same status as the budget and time schedule. The Quality Assurance Program has to be followed up by a Quality Control Plan. This plan is a tool for the project team and a document that makes it pos-

sible for the building owner to control and follow up the goals. The quality control plan defines goals and related sub goals, defines milestones through the planning and construction phases, and specifies who is responsible for each task. The introduction

of an environmental assessment scheme, e.g. BREEAM, LEED or DGNB can be introduced as a Quality Control Plan and be a useful tool in assessment and documentation, see info box below.

### Environmental assessment schemes



The DGNB sustainability concept covers the following key aspects of sustainable building: environmental, economic, sociocultural and functional aspects, technology, processes and site. The assessments are based on the entire life cycle of a building.

The complexity of the goals pursued in environmental assessment schemes such as Building Research Establishment Environmental Assessment Method (BREEAM), Leadership in Energy and Environmental Design (LEED) or Deutsche Gesellschaft für Nachhaltiges Bauen (DGNB) put high demands on holistic performance of buildings and urban districts, as well as a cross disciplinary approach in design processes. For example, in a BREEAM-process, as in ID, an early agreement of common goals within the design team is important. A particular role is given to an assessment scheme advisor in following the design process and ensuring that the specific goals are obtained. Some points in the assessment schemes may have to be collected in early phases of the design process, so attention has to be paid on right timing. In order to achieve a desired classification target, it is crucial that appropriate actions are taken at the optimal time for the maximum benefit. In addition to energy supply and energy efficiency, a range of topics may become decisive for the building design. In BREEAM NOR, there are 9 chapters relating to various environmental criteria. The topic of Energy constitutes one chapter and counts 19% of the total score. The other chapters handle Management, Health and comfort, Transport, Water, Materials, Waste, Land use and ecology, Pollution, and finally there are points available for Innovation. The design team will have to decide which of these topics to pursue in depth to reach the desired rating.

The role of a BREEAM AP is to provide the design team with advice on environmental assessment as well as general advice regarding built environment sustainability and environmental design. An AP will facilitate the team's efforts to schedule activities, set priorities and negotiate the trade-offs required to achieve a target rating. BREEAM is originally an "assessor led" process through which designers submit evidence to an accredited individual who assumes no design responsibility. An AP can fill the gap between the designer and the assessor, and can help design teams meet the client expectations.



### 3.3 - Evaluate the design and document the achievements at critical points/ milestones

The goals need to be monitored through the problem solving process. The transitions between design phases can be viewed as milestones where the current status of the design is evaluated, major decisions are made, and documentation is produced.

The documentation may include updated quality assurance plans and control plans, energy and power budgets, and performance specifications. If the project has an ID facilitator, this person may be in charge of doing the supervision.

Whether or not an ID facilitator is employed, it is important that whoever is the supervisor has the authority to challenge the design team and the client, and can report to the client on progress against the project goals as originally defined.

## STEP 4

### DELIVERY

#### 4.1 - Ensure that the goals are properly defined and communicated in the tender documents and building contracts

In any construction project, designing a high performance building (however challenging it may feel) is less difficult than ensuring the same building is successfully delivered on site.

Where the main contractor has not already been included in the design development process, this can be especially challenging. It is therefore important that the client, design team and potential main contractors understand the importance of gaining a thorough understanding of the proposed design, and that the client ensures that the main contractor takes the responsibility for achieving the project goals.

It is important that the quality requirements set during the design phase is followed up in the construction phase.

Special items to be aware of in the construction phase include:

- Tender and contract documents should require contractors and subcontractors to verify and document specific high-performance goals during construction.
- Every change and alternative solution or material use should be checked on a conceptual level; the

risk of introducing contradictory details or components should be carefully avoided.

- Technical performance parameters of relevant core components must be documented because of their central influence on total achievement.

#### 4.2 – Motivate and educate construction workers and apply appropriate quality tests

Motivation and education of workers about crucial construction operations and material handling (e.g. thermal bridges, air-tightness, low carbon and low emission materials, waste separation) should be ensured.

Spot checks and partial commissioning during construction with corresponding quality tests are recommended at crucial points in the progress and in case of unexpected events (e.g. BlowerDoor test – airtightness control, and consequently repairing of weak points, infiltrations, bad quality parts, etc.).

### 4.3 - Facilitate soft landing. Make a user manual for operation and maintenance of the building

After completion of construction, the design data should be updated in order to provide final information for future operation of the building, typically through Facilities Management (FM) function internal to the owner/occupier or externally contracted. “Record” drawings and user manual for operation should be handed over to client/owner by point of takeover, and these should also comprise the original project goals as defined by the client and design team and an explanation of how the design ethos achieves these goals. Wherever possible, a ‘Soft Landing’ approach to the handover of the building should be provided, where the contractor and design team specialists support the FM staff as they learn how to best operate the building. To ensure proper inclusion, detailed and quantified ‘Soft Landings’ requirements should be included in the project tender (and potentially as part of the project goals).

A monitoring program of the systems should be recommended to the client/owner, in particular if there are experimental parts. The operating staff and the users should be educated and familiarized with the operation of the systems.

## STEP 5 IN USE

### 5.1 – Facilitate the commissioning process and examine the functionality of the technical system

There is no way of knowing for sure that buildings with an energy-efficient design will actually be energy efficient in real operation. In many cases buildings do not fully exploit their potential in terms of energy efficiency and sustainability due to problems and deficiencies in building commissioning and operation. Many buildings are operated without a proper building system regulation and many building automation systems run in default mode.

In this context the phase of building commissioning is crucial, which is why ID emphasizes this issue: The ID approach makes sure that functional tests performed during commissioning do not only check whether technical systems work at all, but also if they work properly by ensuring that the technical system is in line with the design requirements.

During the design phase it is necessary to create favourable conditions for the later commissioning phase by implementing the following tasks:

- Preparing a detailed description of the technical building systems including a traceable definition of envisaged operation paths: How should the technical systems operate under different fra-

mework conditions? This output of integrated design – which conventional design usually ignores – gives clear guidance for the programming of building automation systems.

- Developing and implementing a monitoring concept which makes sure that the necessary data for comparing the actual performance with the target performance will be available when commissioning the building.

During the commissioning phase the following activities need to be implemented:

- Checking whether the monitoring system delivers all the data required in satisfactory quality;
- The technical system’s target performance needs to be compared with the actual performance on a regular basis.
- Measures for improving the performance need to be developed if the target-performance comparison shows deviations – usually this leads to adjustments of the building automation system.
- It is highlighted that these tasks require some time – usually it takes 6 to 12 months from the beginning of the building operation.

## 5.2 – Monitor the building performance over time regarding e.g. energy consumption, user satisfaction etc.

Monitoring of building performance is a basis for holistic evaluation over time. Monitoring should be planned while designing, and followed up by a third party after completion. Preferably, a broad basis of assessment for the building performance should be used, and a combination of data is often necessary to evaluate the whole picture of achievement. For example; it is of little use if a building performs excellent regarding energy use, if the users are dissatisfied with noise and poor indoor air quality and as a result the building is abandoned.

Information about actual energy consumption is of importance when assessing the overall impact of the chosen measures. As a range of reports state discrepancies between calculated and achieved energy consumption, questions are raised regarding whether or not energy modelling can reflect expected achievements. Also, since high energy standards usually involves enlarged volumes of insulations materials as well as increased technical installations, the impacts of these extra investments could be tracked through lifecycle analyses (LCAs), and compared with actual gains. Indeed, building reviews including monitoring data combined with LCA analyses may in the end of the day give useful feed-back on building policies and codes.

## Integrated Design - in a nutshell

- ID is an evolution of current best practice collaboration & Integration
- ID analyses Client Brief and enhances with cooperative input
- ID uses multiple early concepts and modelling to optimise scheme
- ID embeds quantifiable goals & checking into design & delivery

This guide was written as part of the IEE (Intelligent Energy Europe) project MaTrID (Market Transformation Towards Nearly Zero-Energy Buildings Through Widespread use of Integrated Energy design).

The text is partly based on earlier versions of IED reports, and is developed in collaboration within the group participants.

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## Links & references

[www.integrateddesign.eu](http://www.integrateddesign.eu)

[www.worldgbc.org](http://www.worldgbc.org)

- World Green Building Council

[www.bpie.eu/nearly\\_zero.html](http://www.bpie.eu/nearly_zero.html)

- nZEB, nearly Zero Energy Building

Environmental assessment methods and rating system for Buildings;

[www.breeam.org](http://www.breeam.org)

[www.usgbc.org/leed](http://www.usgbc.org/leed)

<http://www.dgnb.de/en/>

[eplca.jrc.ec.europa.eu/](http://eplca.jrc.ec.europa.eu/)

- The European Platform on Lifecycle assessment, LCA

[ec.europa.eu/environment/gpp/lcc.htm](http://ec.europa.eu/environment/gpp/lcc.htm)

- The European Platform on Lifecycle costing, LCC

# CASE II

## Childcare Centre, Cologno Monzese – Italy

### Project details:

Client: Municipality of Cologno Monzese

Architect: Arch. Lorenzo Iachelini

Contractor: Temporary Association of Companies composed by DMC s.r.l. and Mori Legnami

Construction costs: ~ € 500 000

Project size: 580 m<sup>2</sup>

Contract method: public auction with largest discount only for the execution of work described in the detailed design

Year of completion: 2010



### Integrated Design process

A strict collaboration among all designers throughout the whole design process and construction development allowed to achieve an ambitious

energy target and realize a high-performance public facility that provides a comfortable environment for children and teachers, by using little energy and having a reduced impact on the environment.

Source: Technical office of Cologno Monzese.



### Achievements:

- The building achieves the A+ class according to the energy certification protocol defined by the regional law DGR VIII 5018,
- Thanks to this intervention, the Municipality of Cologno Monzese has been rewarded with the European GreenBuilding Partnership,
- This building won the 2010 European Green-Building Award in the category Best New Projects,
- This intervention has been mentioned among the best projects of the competition Premio

- all'innovazione amica dell'Ambiente 2009,
- North facing skylights effectively and pleasantly illuminate indoor environments,
- A ground water heat pump is used to efficiently generate heat,
- A mechanical ventilation system coupled with a high efficiency heat recovery unit provides a good indoor air quality by saving a great amount of energy for heating,
- Electricity produced by a PV array with an area of 110 m<sup>2</sup> covers most of the electricity demand of the whole building.



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