Adapting the principles of Integrated Design to achieve high performance goals: Nearly Zero Energy Building in the European market

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ABSTRACT
The building design phase is of particular importance. Integrated Design (ID) in general is a valuable approach to reduce the complexity of the design process and facilitates the interactions between the members of the design team. For the purpose of reaching high sustainability performance, the alternative building and technical solutions should be developed and discussed by an integrated, multidisciplinary team. It is not limited to energy efficiency and goes beyond this issue. However, ID is not a new notion or concept, but rather an enhancement of good practice as design processes are moving towards greater complexity. 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. In this context early design phases offer an 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. 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. Late attempts of improvements are also likely to result in only moderate gains in performance. The 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 by 2020 (http://www.integrateddesign.eu/). In order to accelerate the application of ID processes in European countries a clear step by step explanation about the ID approach is necessary. Hence, on the basis of generated knowledge form the project INTEND (http://www.intendesign.com/) we developed an ID Process Guide. The guide will be translated into national context of 11 European partner countries. Also a client and a tenant brief were prepared as well as supplements on scope of services and remuneration models. Furthermore, among European project partners about 20 Integrated Design pilot projects are accompanied and documented. Gathered know-how from those large scale tests will be disseminated and thus set best practice examples which can be easily multiplied. Within the framework of the project the GreenBuilding Integrated Design Award has been launched. ID processes in non-residential buildings from all over Europe are invited to apply annually. The benefit of EU collaboration is to cross-pollinate best practices among leading European countries. On this basis practical recommendations on possible policy instruments that may support the widespread use of Integrated Design on daily design practice.

KEYWORDS
Integrated Design; Integrated Energy Design; NZEB; 20 Pilot projects among 11 European countries; ID Process Guide; GreenBuilding Integrated Design Award,
1 INTRODUCTION

The global drive towards sustainable development and rising energy prices are putting increasing pressure on building developers and designers to produce buildings with a markedly higher environmental performance. In addition, the building industry is faced with more stringent performance requirements being imposed by markets and regulations. The recast Directive on the Energy Performance of Buildings (EPBD) stipulates that by 2020 all new buildings constructed within the European Union after 2020 should reach nearly zero energy levels. This means that in less than one decade, all new buildings will demonstrate very high energy performance and their reduced or very low energy needs will be significantly covered by renewable energy sources.

In parallel, member states shall draw up national action plans for increasing the number of nearly zero-energy buildings (NZE)B). These national action plans shall include policies and measures to stimulate the transformation of existing buildings which are refurbished into nearly zero-energy buildings. In addition, by 2015 all new buildings and buildings undergoing major renovation must have minimum levels of energy from renewable sources. The implementation of these policy goals requires a major transformation in the building sector during the next few years.

The design of NZEB requires an interdisciplinary approach. Reducing the energy demand in the design phase demands specifications of the different designers and engineers such as architects, building physics or façade designers. For this reason, the introduction of a design team is compulsory for the design of NZEBs.

In this context the building design phase is of particular importance. IED is a valuable assisting approach to reduce the complexity of the design process, to ensure the implementation of defined, to identify pros and cons of alternative variants of design concepts and to allow decision makers to decide based on transparent facts. Only if IED is applied from the very beginning of the design phase we can assume that a cost-effective solution for NZEB can be identified, because only at the early design phases changes of the general design concept can be implemented at low cost. Therefore, the application of IED is part of the best way towards the intended NZEB at low cost.

2 TRANSITION FROM LOW ENERGY TO NEARLY ZERO-ENERGY BUILDINGS

Directive 2010/31/EU (EPBD recast) Article 9 requires that “Member States shall ensure that by 31 December 2020 all new buildings are nearly zero-energy buildings; and after 31 December 2018, new buildings occupied and owned by public authorities are nearly zero-energy buildings”. Member states shall furthermore “draw up national plans for increasing the number of nearly zero-energy buildings” and “following the leading example of the public sector, develop policies and take measures such as the setting of targets in order to stimulate the transformation of buildings that are refurbished into nearly zero-energy buildings”.

A nearly zero-energy building is defined in Article 2 of the EPBD recast as “a building that has a very high energy performance. The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby”.

To achieve a suitable definition, related facts and findings need to be seen in a broader societal context and need to be transferred into a practical standard, taking into account financial, legal, technical and environmental aspects. Analysing the implications identified above, it becomes obvious that most of them interact or require the consideration of one or several societal aspects. Consequently, the principles for an NZEB definition should be built
on the same broad perspective, should take into account all financial, legal, technical and environmental aspects and should meet the present and future challenges and benefits. Hence, a proper and feasible NZEB definition should have the following characteristics (Thomsen, 2011):

- Clear in its aims and terms, to avoid misunderstandings and implementation failures.
- Technically and financially feasible.
- Sufficiently flexible and adaptable to local climate conditions, building traditions, etc., without compromising the overall aim.
- Built on the existing low-energy standards and practices.
- Allow and even foster open competition between different technologies.
- Ambitious in terms of environmental impact and to be elaborated as an open concept, able to keep pace with the technology development.
- Elaborated based on a wide agreement of the main stakeholders (politicians, designers, industry, investors, users etc.).
- Inspiring and to stimulate the appetite for faster adoption.

Consequently, there are three basic principles, each one with a corollary for setting up a proper NZEB definition, addressing the three main reasons and aims for regulating the building sector: reduced energy demand, the use of renewable energy and reduced associated GHG emissions.

1) Energy demand
There should be a clearly defined boundary in the energy flow related to the operation of the building that defines the energy quality of the energy demand with clear guidance on how to assess corresponding values.

2) Renewable energy share
There should be a clearly defined boundary in the energy flow related to the operation of the building where the share of renewable energy is calculated or measured with clear guidance on how to assess this share.

3) Primary energy and CO₂ emissions
There should be a clearly defined boundary in the energy flow related to the operation of the building where the overarching primary energy demand and CO₂ emissions are calculated with clear guidance on how to assess these values.

The achievement of the high performance goals of the implementation of NZEB demands the assessment of the building in a lifecycle perspective both regarding environmental performance (LCA) and costs (LCC). This basis is a major principle of the Integrated Design.

3 THE PRINCIPLES OF INTEGRATED DESIGN

Integrated Design is an approach that considers the design process as well as the physical solutions, and the overall goal is to optimize buildings as whole systems throughout the lifecycle. Firstly, for the purpose of reaching high sustainability performance, the alternative building and technical solutions should be developed and discussed by an integrated, multidisciplinary team. ID emphasizes a decision process rooted in informed choices with regard to the project goals, and on systematic evaluation of design proposals. This approach for building design is paralleling the principles of environmental management referred in the international ISO 14001 standards. Here, identifying and prioritizing goals, and developing an evaluation plan with milestones for follow-up, are central issues.

A shift of approach emphasizes that the very early phases need more attention because well informed decisions here will pay off in the rest of the design process as well as in the lifecycle
of the 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. Considering the whole life cycle of a building, the running costs are 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% (MaTrID workshop, 2013, WBDG 2012). The process of ID emphasizes that the performance of buildings should be assessed in a lifecycle perspective, both regarding costs (LCC) and environmental performance (LCA). Figure 1 indicates the importance of the Integrated Design process at the early phases (Nordby, 2013).

![Figure 1. 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.](image)

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 2. The interplay of Green Building benefits for developers, owners and tenants (WGBC 2013).

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

3.1 The principles

Six steps can be identified for a successful Integrated Design implementation:

- **Project development**: discussion of the project ambitions and challenge initial client presumptions, initiating ID process and preferably make partnering contracts.
- **Design basis**: selection of a multi-disciplinary design team, including an ID facilitator, motivated for close operation, analysis of the boundary conditions. Also refine the brief and specify the project ambitions, preferably as functional goals.
- **Iterative problem solving**: facilitate close operation between the architect, engineers and relevant experts through workshops etc. Use of both creative and analytical techniques in the design process. Discussion and evaluation of the multiple concepts and finalise optimised design.
- **On track monitoring**: Use goals/targets as means of measuring success of design proposals, make a Quality Control Plan, evaluate the design and document the achievements at critical points/milestones.
- **Delivery**: Ensure that the goals are properly defined and communicated in the tender documents and building contracts, motivate and educate construction workers and apply appropriate quality tests, facilitate soft landing. Make a user manual for operation and maintenance of the building.
- **In use**: Facilitate commissioning and check that the technical systems etc. are working as assumed, monitor the building performance over time regarding e.g. energy consumption, user satisfaction etc.

3.2 Benefits and barriers

Integrated Design processes result in higher energy performance: optimization of building form, orientation and facades is reached through open multidisciplinary discussions and design decisions in early project phases, where knowledge about important conditions is exchanged to inform the design of the building. It also contributes to the reduction of embodied carbon as optimized design is given priority before advanced technical systems and control mechanisms. Indoor climate is significantly improved: 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. Running costs of the building are reduced: 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. Another aspect is the reduction of risks and construction defects as improved planning leads to less building faults. Thus; less claiming and money saved. Early involvement of users and inclusion of user needs in the design process may improve the following performance of the building in the operation phase, as well as increase user satisfaction. A high performance building can yield higher rental costs which can be compensated for by a lower energy bill thus the sales value of the building will increase. A green image can also benefit the building owner or tenant organization.

Despite the benefits there are certain barriers that need to be addressed as:

1) Conventional thinking
The building sector is known for being slow accepting new ways of working. ID calls for decision processes and design methods that challenge familiar habits, and require high communication skills. Professionals on both sides of the table must practice in collaboration, and maybe adjust their working habits.

2) **ID seems to cost 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.

3) **Time constraints in initial design phase**
Often developers underestimate 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 pay off in better concepts.

4) **“Skills tyranny”**
As the ID process requires more collaboration between stakeholders who may have diverging goals, conflicts could be accentuated. It is therefore necessary that the team members do not insist on ultimate demands within their fields of expertise, but rather endeavour to work with a holistic approach.

4 **POLICY FRAMEWORK CONDITIONS**

In general, the policy framework conditions in most European countries encourages the implementation of Integrated Design despite the fact that ID processes are not mandatory for building projects. Legislation supports and gives incentives for the widespread application while at the same time strong scientific and technical interest has aroused. The goals and the methods though of the assessment have to be clarified and adapted to each country.

In Austria, the national building codes focus on the technical aspects as well as the building process. Codes include regulations for the use of land, rights and duties of builders during the planning and construction process, as well as regulations for the execution and technical requirements of buildings. However, there are no requirements for Integrated Design. At the moment Austrian requirements for the energy performance of buildings are not too high; therefore Integrated Design is not a key aspect for the construction of functional buildings.

Both international schemes used in Austria, the American LEED system and the British BREEAM, do not include ID as a assessment criterion, although in LEED there are additional scores available for innovations in design.

For the implementation of Energy Performance of Buildings Directive (EPBD), a Ministerial decision for the new ‘Regulation of Energy Performance of Buildings’ (KENAK) in Greece has been issued in April 2010 (Ministerial decision D6/B/5825 National Gazette 407). The Presidential decree necessary for the definition of the qualifications and training of energy auditors was published in the National Gazette in October 2010 (Presidential Decree 100/NG177). Full implementation started in January 2011, for all types of buildings and building use, new or existing undergoing major renovation. KENAK is currently being revised and the new version will be issued by the end of 2014. The nearly-Zero Energy Building (NZEB) has been introduced to the national legislation, by amendment, in June 2010 and it coincides with the precise EPBD definition. This definition is also included in the recently elaborated recast of the law for the energy efficiency of buildings. Directive 2010/31/EU (EPBD recast) has been adapted by the Greek legislation Energy Performance of Buildings- Harmonization with the Directive Directive 2010/31/EU (Law Number 4122, National Gazette 42) of February 2013. The law specifies that after 1 January 2019 every new
building of the public sector should be NZEB. This obligation is also applied to all new buildings constructed after 1 January 2021.

BREEAM-NOR is the Norwegian version of the Environmental assessment scheme BREEAM. The scheme does not give specific points for ID today, however points are given for using a BREEAM accredited professional (AP) as a facilitator. Common for both approaches is a focus on team-work, timing and quality control in the design process. As the process of BREEAM-certification is similar to ID thinking and the role of a BREEAM AP is very much like the role of an ID facilitator, it could be discussed if these roles should be merged. In Norway, the building codes are geared towards technical solutions and calculated energy use per square meter, and to some extent on avoiding hazardous materials. Focus on design processes is absent. However, in larger scale planning processes/ zoning, the process is firmly predefined and includes public hearings etc. to ensure that the various affected parties can express and advocated their interests. With reference to planning processes, it could be argued that optimal design of buildings (public as well as private) is in the public interest and depends on predefined and cleverly managed design processes.

A specific focus on the design process is absent in Italy, but, just for public buildings, the Decreto del Presidente della Repubblica (DPR) n. 207 published on 5/10/2010, obliges to verify the projects to be put out to tender, which are not yet approved. In particular, this law specifies that the verification of the project is designed to ensure the compliance of the chosen design solutions with the specific functional, performance, normative and technical provisions, contained in the feasibility study, preliminary design document or in the conceptual design. Several Environmental assessment schemes are used in Italy although their adoption in not mandatory on the whole national territory. The most adopted Environmental assessment schemes in Italy are the ‘ITACA Protocol’ and the ‘LEED Italy’.

5 THE MATRID PROJECT

MaTrID aims to support the implementation of Nearly Zero Energy Buildings by 2020. In this context the building design phase is of particular importance. Integrated Energy Design (IED) is a valuable approach to reduce the complexity of the design process and facilitate the interactions between the members of the design team. IED allows them to provide the best solution for the whole building. MaTrID’s targets are harmonized with the Integrated Design process as described in the previous section. (Leutgöb, 2012)

5.1 Objectives

The objectives of the proposed project have been identified based on a holistic IED approach. Activities are needed on the side of the building owner (developer) as well as on the side of designers. Starting from this, the following specific project objectives can be derived:

1) Establishing the general understanding on the advantages and requirements of IED at the side of real estate developers and building owners: In this context, the project aims at convincing opinion leaders of builder’s associations, big property developers or other multipliers that IED is the way to be chosen for the design of cost-efficient NZEB.

2) Improving the know-how basis on IED: The application of IED requires practical know-how on the developer’s side as well as on the designers’ side. Therefore the project aims at developing practical tools, such as specific text modules for client briefs as well as for IED related contracts and remuneration models.

3) Testing the practical implementation of IED on a large scale thus setting best practice examples which can be easily copied and multiplied

4) Development of a common tool-kit for the integrated energy design of NZEB
5. Clients brief for NZEB
   o IED-related model contracts
   o IED-friendly remunerations models
   o User-friendly IED guideline

5.1 Adaptation of the common tool-kit to national requirements
5.2 Implementing EU-wide promotion and dissemination activities
5.3 Drawing conclusions for a further market adoption of IED in the years after the end of
   the project including also practical recommendations on possible policy instruments
   that may support the widespread use of IED on daily design practice.

5.2 Focus area

The construction, architects and engineering market is very much focused on regional and
local level. Additionally, the state of the art for IED in the participating countries is very
different. For this reason, the emphasis of the project is on widespread market adoption on
national level. National activities are country specific and reflect the respective demand.

5.3 Benefits

The greatest benefits are provided only if applied in the earliest stages of the project, when
changes to the design are still easy to implement. The benefit of EU collaboration is to cross-
pollinate good practices among leading European countries (including clients, private
industry, public sector, etc.). Knowledge transfer among Europe and various actors is the
main benefit of MaTrID.

5.4 Outcomes

The outcomes of the project can be summarised as follows:

- A general understanding on the advantages and requirements of IED on the part of real
  estate developers and building owners as well as on the designers’ side.
- Practical tools – such as specific text modules for client briefs as well as for IED
  related contracts and remuneration models – which can be directly applied in daily
  practice.
- Successfully tested pilot projects with practical implementation of IED on a large
  scale. Examples can be easily copied and multiplied.
- General acknowledgement of IED beyond the limits of the participating countries.
- Conclusions for a further market adoption of IED in the years after the end of the
  project including also practical recommendations on possible policy instruments
  that may support the widespread use of IED on daily design practice.

In order to increase the visibility of the Integrated Design approach, the GreenBuilding
Integrated Design Award (GB ID Award) has been launched in the framework of the
European GreenBuilding programme and the European project MaTrID. The GB ID Award
aims to highlight the use of exemplary ID processes in design and construction.

6 CONCLUSIONS

The European Union (EU) aims at drastic reductions in domestic greenhouse gas (GHG)
emissions of 80% by 2050 compared to 1990 levels. The building stock is responsible for a
major share of GHG emissions and should achieve even higher reductions of at least 88% -
91%. Therefore, without consequently exploiting the huge savings potential attributed to the
building stock, the EU will miss its reduction targets. More than one quarter of the 2050s building stock is still to be built. The energy consumption and related GHG emissions of those new buildings need to be close to zero in order to reach the EU’s highly ambitious targets. The recast of the Energy Performance of Buildings Directive (EPBD) introduced, in Article 9, “nearly Zero -Energy Buildings” (NZEB) as a future requirement to be implemented from 2019 onwards for public buildings and from 2021 onwards for all new buildings.

Integrated Design (ID) is necessary in managing the complex issues arising from planning buildings with high energy- and environmental ambitions. In these processes, emphasis is on collaboration in multidisciplinary teams as well as on clear goal-setting and systematic monitoring. In the early design phases, the opportunity to positively influence building performance is great, while cost and disruptions associated with design changes are very small.

The guiding strategic objective of the MarTrID project is to contribute significantly to a widespread market adoption of integrated energy design of buildings. IED should become the standard way of European building design within 2020. As a result real estate industry will find it easier to cope with the challenges coming from energy and climate change policy by producing sustainable buildings with very high energy performance in a cost-effective way, calculated over the life cycle of the building.

7 REFERENCES


Expert experiences discussed at the first training session within the MaTrID framework http://www.integrateddesign.eu/toolkits/workshops.php