

THE MOVE TOWARD NET ZERO ENERGY BUILDINGS

Experiences and Lessons from Early Adopters



Issue Brief

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INTRODUCTION

Around the world, engineers, architects and policymakers have been exploring ways to deliver highly efficient buildings whose reduced energy demand is satisfied by clean, renewable energy. Building off of the broader concept of a green or sustainable building, the concept of the “net zero building” focuses on the energy dynamics and performance of the building. And as policymakers and leaders align toward the net zero concept, the focus on achieving deep energy efficiency has centered on integrated technologies as well as ways to connect buildings to the natural environment. Lessons learned from early efforts can help to inform the next generation of best practices.

Early projects demonstrate that net zero energy buildings (NZEBS) are feasible and potentially economical even in the shorter term. However in each case, the project developers have faced a number of challenges, invoking some skepticism and uncertainty around the nearly/net zero energy concept. Based on interviews with representatives from over a dozen project implementers,¹ three commonly cited challenges include:

- Processes and transactions costs
- The level of technology awareness
- The engagement of building occupants

This paper considers both the direct and indirect experiences of project developers, key stakeholders and policymakers involved in net zero energy construction and major retrofit activities in commercial and public-sector buildings.

The findings of this research are intended for, among others, commercial and public building managers and decision-makers seeking to optimize cost and resource efficiency (energy, water and waste) as part of long-term building asset management strategies.

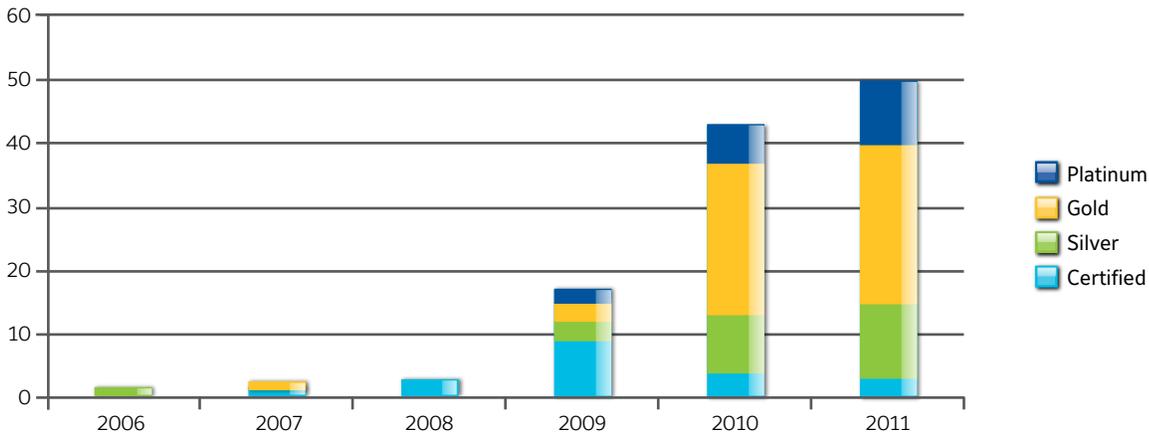
MOTIVATIONS FOR CREATING NET ZERO ENERGY BUILDINGS

One of the most common goals for the individuals undertaking net zero projects was to showcase and demonstrate “the art of the possible” in terms of achieving high energy and sustainability performance in buildings. Among the dozen projects reviewed, the main goal was not to achieve an NZEB per se, but to create highly efficient or near-zero-energy buildings. Most projects were driven by a mix of traditional factors and concerns – long-term cost and resource savings, occupant well-being and environmental responsibility – combined with the desire to illustrate the effect of combining today’s technologies and with the right ideas and innovations. Rarely, if ever, was one single factor decisive in driving an NZEB project; in the majority of cases, the communication of an “environmental champion” image was more important than cost savings.

The influence of green trends cannot be underestimated. One project representative claimed that “Everybody is doing it,” referring to what may indeed be a broader market transformation toward sustainability in the built environment. Indeed, experiences from the development of green buildings may be considered a precedent for the evolution of NZEBs. As Figure 1 illustrates, the number of European building projects certified using the LEED rating system has increased dramatically over the past decade.

¹ Interviews conducted by IBE staff between November 2011-January 2012, names and project information can be found in the Acknowledgements and Appendix A.

Figure 1. Growth of the number of LEED certified buildings in Europe



Source: US Green Building Council Global Public LEED Directory

While studies have begun to quantify the value of 'going green' in terms of higher rent and sale values for energy efficient and LEED buildings,² the smaller data set makes it more challenging to quantify the additional value of a net zero building. Respondents clearly noted that they believed net zero could influence the valuation of the space. The sense of a possible market premium did influence project decision-makers.³

CHALLENGES TO ACHIEVING NET ZERO ENERGY

Several project representatives reported that local (especially municipal) rules and regulations hindered rather than supported their NZEB ambitions. Obtaining the necessary permits, such as fire security approval for wood-based construction, was a particular challenge in several cases.

Some project representatives reported challenges in communicating their NZEB vision to local authorities, and communication challenges also extended to employees and other building users and occupants. Projects seemed to struggle in particular around how to make energy savings visible and around choosing the correct central message to convey. For example, should the motivating slogan revolve around energy savings and environment? Or around occupant health and well-being? Or both?

While the issue of economic value is discussed more in the next section, significant challenges for several projects included the perception of high cost and disbelief or distrust in the actual savings and energy performance (technology) that could be achieved. The idea that buildings can be more efficient and environmentally friendly, as well as more pleasant for tenants and less costly, is not necessarily widespread.

Another fairly prevalent perception was that the transaction costs involved in integrated design processes and other elements of NZEB projects were too high. This translated into challenges for project leaders, who had to communicate and justify why deploying more time, energy and resources up front was necessary to ensure smooth project delivery overall.

Technical challenges related to the procurement of competent service providers, the appropriate technology choices, and the writing of tendering documents were also identified in some cases.

The next three sections regroup the main findings of our research, focusing on challenges and barriers to translating the nearly/net zero energy concept into reality.

² <http://www.institutebe.com/Green-Building/multiple-studies-document-green-buildings-add.aspx>

³ A 2010 Deutsche Bank Research publication entitled 'Green Buildings: A Niche Becomes Mainstream' provides interesting insights on this topic: www.rreef.com/research/research_3981.jsp

FINDINGS AND RECOMMENDATIONS

1. Processes and transactions costs: Start early, seek advice and stay engaged

For project developers, it is important to engage in early and integrated planning so as to exploit all possible options during the design phase to reduce energy demand and source energy on site. In particular, local rules and regulations need to be examined and understood during this phase, since failure to obtain the proper permits may cause significant project delays. Available incentives and subsidies, as well as financing options, also need to be considered and examined as a priority early in the process.

Once the project is underway or completed, it is critical to stay closely engaged with both the building and its occupants, and especially to make any adjustments to technologies and systems, as performance may differ from projections.

Policymakers wishing to promote the adoption of NZEBs may want to consider education and awareness measures targeted at local authorities charged with permitting and rules for NZEBs in their jurisdictions, especially since net zero energy may present an entirely new challenge for many local officials. Local authorities are not the only actors who need to be trained and informed regarding NZEBs; in order to create the optimal market conditions for NZEBs, the knowledge and the competitiveness of existing contractors also must be taken into account. “NZEBs are no longer an unknown process, but finding contractors capable of building this kind of construction on deadline and within a reasonable budget is very hard,” said an architect involved in the construction of a passive office building in Brussels. “The day the market will offer a wide supply of informed and NZEB-trained contractors, automatically the prices for these buildings will go down.”

One of the most distinguishing features of NZEB projects in comparison with more conventional projects is the use of an integrated design process, whereby architects, engineers, contractors, project developers and even building occupants convene early in the project cycle to develop a holistic strategy to reduce costs, better anticipate building use patterns, and exploit synergies in energy saving opportunities.

Some form of integrated design process was common in all projects surveyed, whether in new construction or retrofit. In one case, 10 different players were involved in the process. Surprisingly, all parties characterized the process as “easy,” since all were interested and keen to see how savings could be achieved through collaboration.

An integrated design process may appear more time-consuming at first sight, especially since planning cycles even for traditional building construction and major retrofits tend to be quite long. However, most of the projects examined took less than two years to complete. This suggests that greater effort at the initial planning stages may reduce overall project time. At a broader, macroeconomic level, it may also suggest that with proper planning, policy support, market conditions, and with political investment regarding highly visible projects, Europe should be able to achieve its 2018/2020 NZEB targets.

The architect involved with the passive office building in Brussels stated, “It’s impossible today to build an energy efficient construction without an integrated design process. We don’t know how to do it alone, but when people share knowledge and know-how, it becomes feasible. This helps us

to think out of the box.” Furthermore, Bogdan Atanasiu, Senior Expert in Energy Efficiency at the Buildings Performance Institute Europe advises: “When retrofitting commercial buildings, planning the implementation steps is very important. In order to fit in budget, the retrofit should start as much possible with the measures with the shortest payback period, or with the measures delivering an important amount of savings. Being paid back on a normal business timeframe will create incentives for next steps and will strengthen confidence in moving further.”

That being said, some project representatives did indicate that greater incentives may be needed to stimulate integrated design processes and collaboration at broader market scale, especially since there may be initial mistrust between established professions, notably architects, engineers, contractors and real estate professionals. Public authorities and regulators may also be unfamiliar with a nontraditional approach to building design, construction and retrofit, suggesting that educational and outreach work may be appropriate for those audiences. This issue is also addressed in the next section.

There were also significant discrepancies in how projects were paid for, although the majority seemed to rely on traditional bank or owner financing, with support from local or national subsidies. “When people plan to create a zero energy building, they think only about the investment cost and don’t look further,” observed the CEO of a net zero energy hotel in Vienna. “To create this kind of construction, you need to be passionate about the project, well informed and courageous. Energy efficiency in buildings is about attitude – the attitude to invest money.”

Further work is necessary to examine financing issues related to NZEB construction and retrofits, although existing research suggests that innovative financing mechanisms for nonresidential NZEB projects are not widespread in markets today. “People need to get convinced to do it because it is new and unusual, and of course it is more expensive to build such a structure,” said the project developer of a major net zero energy retrofit in Belgium. “But more and more people are starting to realize that not only the price that you pay to build a house matters, but also the price of living in a healthy environment.”

The difficult economic climate and the lack of energy efficiency incentives and targets, particularly in Europe, also create delays in development of such instruments.

2. The level of technology awareness: Map available technology and service suppliers

Technology awareness may be challenging, since firms may not have the time or expertise to identify the best suppliers, system integrators and vendors for their NZEB projects. However, it is critical to understand as early as possible what kinds of technologies and systems the market can provide before embarking too far down the path of construction or retrofit, as the choices may have significant consequences on budgets and project timeframes.

Among early technology and design decisions, air tightness, windows, insulation and other building shell attributes were seen as critical in most of the projects. These must be well selected, and the building shell must be well designed, both because of the higher cost of these technologies and because of their impact on energy performance. In parallel, other technologies and systems installed should be intelligent and flexible in order to adjust for occupant use patterns. “NZEB projects are like

racecars: Everything needs to be perfect,” said an architect involved in construction of a zero energy primary school in France. “The project developers need to motivate the construction team because they need to go further than normal. It’s a new challenge for humanity: Do more with less.”

The use of natural ventilation in dense, polluted and noisy urban settings may present an important technical challenge. This emerged in only one project, but the issues must be considered, especially in the context of urban sustainability and the connectedness of systems. Interestingly, there seems to be little commonality among projects in terms of labels and standards used. Some projects reported a lack of appropriate labels in the markets, while others used a Passive House standard or an Ecolabel as part of their strategies. Several interviewees expressed a desire for greater clarity and commonality of labels in their markets. An NZEB project developer from Austria observed, “I was never interested in the LEED or other certification because I don’t want to sell my building. People invest a lot of money in order to obtain famous certifications when they want to sell the building.”

3. Engaging building occupants: Creating a common vision and long term value

Creating and communicating a compelling vision around the NZEB building is critical to ensuring buy-in from a range of stakeholders, most notably the building’s actual users.

Many interviewees pointed out that communicating the life quality and intangible (i.e., nontechnical and nonfinancial) benefits of the NZEB project is more compelling for occupants. Some experts point out that one reason nontechnical messages may be more compelling is that while people may “fall in love” with buildings, they may not necessarily have similar emotive responses to energy saving technologies, for example.

Gerry Faubert, former Director of Integrated Design at the HOK architectural firm, recalls that for the Net Zero Court project in St. Louis, Missouri, USA, “The challenges were to define affordability and to really balance how much energy efficiency one can afford to buy up front, versus being able to achieve a zero emissions proposition.”

A careful balancing of costs and benefits is common in any retrofit or new construction project. In the realm of net zero energy, high energy performance, and sustainability in buildings generally, the total cost of ownership is frequently used in reference to a more holistic understanding of value: Short-term returns on investments must be contrasted with longer-term benefits including energy and resource savings, higher ‘green’ market value, and occupant well-being and productivity.

As discussed in the first section on motivations, most respondents in this study agreed that the economic rationale and value assessment of their projects necessarily extended beyond short-term economic considerations.⁴ Tellingly, none of the projects reported a negative impact on occupant well-being or productivity. On the contrary, all projects indicated that while there may have been initial questions or concerns about the project, occupants and users were generally more than satisfied in their NZEBs. “In the old building, people were used to working in small rooms, where they could fix the temperature,” said the facility manager of the WWF Headquarters in The Netherlands. “Now, in the new building, they work in an open space where heating and air conditioning are centrally managed. They were skeptical just because it was a new situation, but now they are proud of the building.”

² Representatives of high performance buildings queried in a 2010 study by Danfoss also suggested that it is important to educate “all professionals involved in building development on how and why high performance buildings make good business sense – that the long-term payoff more than justifies the initial investment and puts that investment in perspective.” (Danfoss, 2010)

In some cases, the building's NZEB credentials actually produced a noticeable increase in the engagement of occupants around sustainability, meaning occupants became more active in helping the building to achieve its energy performance potential. This carries potentially significant implications for return on investment: If the NZEB inspires occupants to become "green champions," the return on investment should, in principle, increase, since occupant behavior may lead to even greater energy and resource savings than initially projected.

In addition, some of the NZEB projects examined are attracting curious visitors and eco-tourists who want to learn more about such buildings. One project actually hired an extra full-time staffer solely to deal with media and other interested parties. "I didn't realize how important it was to build a zero energy hotel until I did it," said the CEO of the net zero energy hotel in Vienna. "After that, journalists around the world wrote about our story, delegations from different governments asked for guided tours, and the occupancy increased. I believe that everybody thought about me: 'She did it. She proved that it works for hotels, and moreover, she makes business with it.'"

⁵ The abbreviation NZEBs is used in this text to refer, broadly, to net or nearly zero energy and passive buildings, which are generally considered highly efficient, renewable energy fed buildings that generate as much or even more energy – in the form of heat, electricity, cooling, etc. – as they consume. Please also see the Institute for Building Efficiency's 2011 'Roadmap to Net Zero Energy Commercial Buildings,' available at: <http://www.institutebe.com/Green-Building/A-Roadmap-to-Net-Zero-Energy-Commercial-Buildings.aspx>

⁶ Agreed in 2009 and 2010 as part of the negotiations over the EU's revised framework building efficiency law – the Energy Performance of Buildings Directive (EPBD) – the term 'nearly' reflects a political compromise agreed between supporters of net zero energy targets and proponents of a less ambitious target. While the precise definition of nearly zero will be established by individual EU countries over the course of 2012 and beyond, in practice the term means that a small amount of nonrenewable energy use will be permitted in buildings carrying a nearly zero energy distinction. The term is also often used synonymously with 'passive house' or building.

⁷ See the Zero Net Energy Action Plan for the Commercial Building Sector at: http://www.engage360.com/index.php?option=com_k2&view=itemfacet&layout=generic&tag=find&task=tag&Itemid=180&lang=en

CONCLUSIONS

Evidence from project experience shows that NZEBs are feasible, potentially economical even in the shorter term. Project proponents believe that, in general, NZEBs perform at least as well as if not slightly better than conventional buildings.

Cost and performance are not necessarily the main motivating factors for going to net zero energy. Projects seek to demonstrate the benefits of integrated design, long-term economic value, and healthier occupant spaces. The pioneers in net zero have put a range of options on the table.

New decision-makers interested in exploring net zero can be well served by examining the lessons from these pioneers. In pursuing net zero building design, they will also be faced with weighing advantages, such as perceived increased health benefits from daylighting and natural ventilation, with disadvantages, such as more complex design and permitting. Does it make sense – all things considered – to make the move to net zero energy? If the 'cocktail' is right it may, but no single factor, whether sustainability or saving money or other, is likely to be singularly persuasive.

APPENDICES

Policy Background

A growing number of stakeholders globally – from architects and building engineers to national and international policy makers – are attempting to reduce the energy consumption, operating costs and the environmental footprint of buildings. The latest and perhaps most ambitious of these efforts relates to the achievement of net zero energy buildings (NZEBs).⁵

Policymakers in the European Union (EU) have mandated that all new public buildings achieve nearly zero energy status by 2018, and that all other new buildings achieve the same status by 2020.⁶ In the United States, states like California have undertaken a comprehensive stakeholder engagement process with the aim of achieving net zero energy status for commercial facilities by 2030.⁷

Methodology

This zero energy building movement is likely to carry important implications for a range of actors across the building chain, including:

- Commercial and public building owners and operators
- The commercial real estate sector
- Engineers and architects
- Financiers
- Building occupants and users
- Local, national, regional and international policymakers

While this research paper does not seek to address all of the possible issues and implications of going to net zero energy, it provides a first step in assessing the extent of these implications, offering learnings, observations and recommendations that may be applicable and of interest for each of the target groups outlined above.

Institute for Building Efficiency (IBE) researchers engaged in five areas of activity to support this research:

1. Interviews with representatives from existing NZEB projects, notably in Europe
2. Engagement and conversations with a range of stakeholders
3. An IBE expert workshop on Sept. 14, 2011, in Brussels (see Annex I)
4. A review of available literature
5. Collaboration with the Johnson Controls Building Efficiency business.

While there are numerous and exciting residential NZEB projects completed or underway, this paper is concerned only with nonresidential cases – commercial and public facilities.

Projects Interviewed for this Study

Representatives from the following NZEB projects were queried:

In new construction:

1. Elithis Towers, Dijon, France
2. Plus Energie/Passive Sports Hall, Herrieden, Germany
3. Solvis Factory, Braunschweig, Germany
4. Zero Energy Primary School – Antoine de Saint Exupéry, Pantin, France
5. Nature Park Information House, Zwiesel, Germany
6. Wicona Test Centre, Ulm, Germany (connected to existing building)

7. Aeropolis Office Building, Belgium
8. Environmental Technology Center Sonoma State, Rohnert Park, California, USA
9. Hawaii Gateway Energy Center, Kailua-Kona, Hawaii, USA

In major retrofit:

10. WWF Headquarters, The Netherlands (partial new construction)
11. Boutiquehotel Stadthalle, Vienna, Austria (partial new construction)
12. Solar Company, Heusden-Zolder, Belgium
13. Passive School, Schwanenstadt, Austria
14. IDeAs Z2 Design Facility, San Jose, California, USA

The IBE also conducted a prior interview and podcast in the United States with a representative of the Net Zero Court Project in St Louis, Missouri. In addition, lessons learned from Johnson Controls work on a range of high-performance building and zero energy projects have informed this report.

Please refer to the table in Annex II for an overview of the different factors – motivations, financing, challenges, and lessons – observed in each project whose representatives were interviewed for this report.

ACKNOWLEDGEMENTS AND REVIEWERS

The authors are grateful for the thoughtful reviews and comments we received throughout the research and production of this study. Started through an IBE workshop on challenges to achieving NZEB in the European Union and a dozen of interviews conducted between November 2011 and January 2012 with representatives of Nearly/Net Zero Energy Building projects, the research process and written report benefited from insights provided by a variety of collaborators and reviewers:

Sabine Leribaux, Architect, Architectes Associés, Belgium

Emmanuelle Patte, Associate Architect, Méandre Atelier, France

Pia Regner, ING + ARCH Partnerschaft, Germany

Oscar Hernandez, Engineer, Elithis groupe, France

Bogdan Atanasiu, Senior Expert in Energy Efficiency, The Buildings Performance Institute Europe, Belgium

Rocky Rohwedder, Chair of the Department of Environmental Studies and Planning, Sonoma State University

Chris Minning, Analyst, Strategy, Building Efficiency, Johnson Controls

Steering committee of the international energy efficiency in commercial buildings (IEECB) conference

LITERATURE AND RESOURCES

The following are select literature and resources that were directly used and cited in this paper and/or are available to interested readers for further reference and information.

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Engage 360 Net Zero Energy Action Plan and other resources: <http://www.buildinggreen.com/auth/article.cfm/2010/9/29/California-Takes-Concrete-Steps-Toward-Net-Zero-Energy-Buildings/>

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ING + ARCH, *Plus Energie/Passive Sports Hall project, Herrieden, Germany*. Available at: <http://www.ingplusarch.eu/ingenieurkonzepte/energiekonzepte/energiekonzepte-detail/energiekonzepte/neubau-plusenergiesporthalle-herrieden/>

ANNEX I – PARTICIPANTS IN THE NZEB WORKSHOP IN BRUSSELS SEPT. 14, 2011

1. Alistair Blyth, International Energy Agency (IEA)
2. Michaela Holl, European Commission
3. Abby Semple, International Council for Local Environmental Initiative (ICLEI)
4. Elisabetta Delponte, Energy Efficient Buildings European Association (E2BA)
5. Silvia Zinetti, Energy Efficient Buildings European Association (E2BA)
6. Richard Bull, De Montfort University
7. Alexandra Notay, Urban Land Institute
8. Sandra Roling, The Climate Group
9. Ingrid Holmes, E3G
10. Casper Tigchelaar, Energy Research Centre of The Netherlands
11. Oliver Rapf, Buildings Performance Institute Europe (BPIE)
12. Bogdan Atanasiu, Buildings Performance Institute Europe (BPIE)
13. Adrian Joyce, European Alliance of Companies for Energy Efficiency in Buildings (EuroACE)

ANNEX II - COMPARATIVE TABLE OF FINDINGS FROM INTERVIEWED PROJECTS

Project	Type	New Construction / Retrofit	Motivations	Challenges	Certifications?	Financing Aspects	Behavior Issues / Occupant Engagement	Use of Integrated Design Process?	Lessons Learned / Recommendations
Passive House School-Building, Schwanenstadt, Austria	Nearly Zero/Passive	Retrofit	Demonstrate that it is possible to transform a normal public building into a passive building.	Convincing public authorities and getting fire permits	Graz Energy Agency	Local, regional and national subsidies	10 to 15 percent of staff and students initially skeptical of project benefits; however, remaining occupants supportive.	Yes, participants were accustomed to working in a multi-disciplinary team.	Architects should analyze and consider all parts of the building during design. In communicating with occupants and users, greater emphasis should be placed on well-being and non-tangible benefits in addition to energy savings and technical aspects.
Aeropolis II Office Building, Brussels, Belgium	Nearly Zero/Passive	New construction	Increase occupant well being and demonstrate feasibility, as well as long-term asset value considerations.	Writing tendering documents and implementing a common working procedure; respect of budget and deadlines	Passive House Platform	Bank loan and subsidies from local authorities	Employees and occupants giving consistently positive feedback	Yes, a critical part of the project and 'impossible' to realize without	Greater standardization needed at European level in order to increase number of projects.
Ecole Antoine de St Exupery, Pantin, France	Zero Energy	New construction	Environmental awareness and cost savings	Explaining the technical elements of the project to local authorities and obtaining permitting, including fire permits.	French HQE certification (Haute Qualité Environnementale)	Support from municipal and regional subsidies as well as the French Energy Agency Ademe	Teachers and students giving positive feedback and pleased with natural lighting and materials.	Yes	The project is less costly when architects take into consideration all opinions given during integrated design process. Also it is necessary to motivate working teams in order to deliver superior energy performance.
Elithis Tower, Dijon, France	Plus Energy	New construction	Putting energy performance to the benefit of building users and occupants.	Creating a building that reconciles aesthetics, urban integration, comfort, energy and environmental performance, all at a 'standard' price.	No, due to lack of appropriate zero energy label at French or European Union level	Private finance plus 3% support from the French Energy Agency Ademe	Employees actively engaged in project on ongoing basis	Yes	Not mentioned.
Boutiquehotel Stadthalle, Wien, Austria	Zero Energy	New construction and retrofit	'Everybody is doing it.' Showcasing what is possible.	Obtaining bank financing and local approvals and permits, including fire permits; communicating the project effectively to guests (some displacement necessary during retrofit)	Ecotag of the Austrian Republic	Owner financing	Staff increasingly engaged after building completed and occupancy has increased. Separate media manager hired to deal with inquiries.	Not mentioned.	Request more support from local government

ANNEX II - COMPARATIVE TABLE OF FINDINGS FROM INTERVIEWED PROJECTS (continued)

Project	Type	New Construction / Retrofit	Motivations	Challenges	Certifications?	Financing Aspects	Behavior Issues / Occupant Engagement	Use of Integrated Design Process?	Lessons Learned / Recommendations
Sports Hall, Herrieden, Germany	Plus Energie/ Passive	New construction	Develop a building that uses as little energy as possible but is still economically advantageous.	Not to create a technically complicated and expensive building.	No	Owner financing	It is important to make the occupants understand the building and assist them in improving energy use.	Yes.	Use decentralized water heating stations.
Solvix Factory, Braunschweig, Germany	Zero Energy	New construction	Optimize energy use	Reconciling standard architectural planning process with integrated design process.	No	Bank loan and owner financing	One engagement tactic used was a weekly happy hour to explain works and encourage 'eco-gestures'	Yes, with good collaboration and interest from parties.	Not mentioned.
Nature Park Information Building, Zwiessel, Germany	Plus Energy	New construction	Reduce environmental impact and showcase what is possible.	Creating a low-energy yet multi-purpose and multi-use facility.	No	Support from a government foundation, owner financing	Not mentioned	Yes	The solar thermal energy and heat exchange system used was too expensive.
Solar Company, Heusden-Zolder, Belgium	Nearly Zero/ Passive	Retrofit	Create an exemplary project as part of the company's public relations.	Summer climate and air tightness	Yes. Certification of air tightness according to the Passive House Standard.	Bank loan	Employees mostly shared the same vision, though it was hard to convince some that the comfort would be the same with reduced energy consumption.	No, but we did get help from an engineering company and an architect.	Advisable to use a control system able to communicate and to monitor the energy consumption of the building
Wicona Test Center, Ulm, Germany	Zero Energy	New building, connected to existing structure built in 1992.	Showcase efficient use of natural resources, reduced energy consumption and CO ₂ emissions without compromising occupant comfort.	Staying within budget and avoiding additional costs.	No	Owner financing	Employees are generally engaged and accustomed to these kinds of projects	Yes	Be more provocative and aggressive in terms of energy savings, and maximize the performance of technologies
WWF Headquarters, The Netherlands	Zero Energy and Zero Carbon	Retrofit of an existing building and addition of a new building	Showcase what is possible and highlight WWF's commitment to this issue.	Occupants not accustomed to working in what is now an open space with a centrally controlled heat, ventilation and cooling system.	Yes. The wood used is Forest Stewardship Council certified. Energy used has the highest level of certification given under a Dutch certification system (overseen by power company)	Owner financing backed by support from a private Dutch foundation	Yes. WWF estimated how much behavioral issues will contribute to targets in terms of carbon emissions and energy consumption. Employees initially skeptical but are now 'proud' of the building.	Yes	Engage in much more exposure: send messages, be open for questions in order for people to know what has been done and what is possible.

The Institute for Building Efficiency is an initiative of Johnson Controls providing information and analysis of technologies, policies, and practices for efficient, high performance buildings and smart energy systems around the world. The Institute leverages the company's 125 years of global experience providing energy efficient solutions for buildings to support and complement the efforts of nonprofit organizations and industry associations. The Institute focuses on practical solutions that are innovative, cost-effective and scalable.

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