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CZGBC

The CZGBC is an industry trade association that promotes development of sound green building practices and projects by and in collaboration with its member companies and institutions throughout the Czech Republic.

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FOREWORD

During the 2009 founding of the Czech Green Building Council two of the fundamental issues that drove the formation of the council were the desire for more information about green building costs and benefits.

Excerpt of the founding principles of the CZGBC

“The CzGBC will drive research critical to the expansion of green building. - Return on investment and costs are critical to the decision of deciding to build green buildings.

The CzGBC will provide outreach and partnership between other green building organizations, which will drive the green building mission forward. – Researching the costs and benefits of green buildings will create synergy between members of the council and the green building supplier network.”

In order to address these two critical issues the Green Value task group was created to prepare a professional design study specific to the Czech Republic; which would quantify the differences in the up-front cost and both short and long-term values of new green buildings relative to typical regional practices.

Our study aims to provide a reputable comparison of office building valuation between more sustainable ‘green’ building practice and typical Czech practice, to guide the market in the interim period before more green projects are realized, and direct data can be compiled.

Based on the results of our study it seems that developers and owners can afford green projects within typical project budgets and that these projects represent real value for money.

ACKNOWLEDGMENTS

The Green Value Task Group wishes to thank the Czech Green Building Council (CZGBC) for their continued support and promotion of sustainable building in the region, and The EFEKT Programme for their financial support of our on-going study.

We would like also to explicitly thank the Green Value Task Group's active members' devotion to our research and their many hours of volunteer work. The specialist work of the Architecture/Engineering team, the Cost Review & Analysis team, the Report Authors and Translators, and the overall Research Project Managers were all crucial in bringing together our varied expertise into a final report that we hope will benefit all sectors of sustainable real estate development here in the Czech Republic.

Finally our great thanks go to Henry Hanson and Carlo Marzot, for their independent peer review of our research methodology and findings. Their experience in the Central and Eastern European market combined with their focus on green building from the design and engineering perspectives, led to invaluable input into the development of our project.

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Glossary	
Base Code Compliant project	Most basic building only complying (but not exceeding) the minimum Czech code requirements
Typical Best Practice project	Most common building type incorporating traditionally accepted international level of performance and finish, above the minimum code requirement
Green Building project	A high quality commercially-viable building, which incorporates a number of sustainability practices
LEED	Leadership in Energy and Environmental Design – an international certification system for the evaluation of the sustainability of buildings
BREEAM	BRE Environmental Assessment Method – an international certification system for the evaluation of the sustainability of buildings
SBToolCZ	Sustainable Building Tool, Czech Republic – a Czech adaptation of an international certification system for the evaluation of the sustainability of buildings
Prague Research Forum	A group of real estate agencies (CB Richard Ellis, Colliers International, Cushman & Wakefield, DTZ, Jones Lang LaSalle and King Sturge) who share non-sensitive information with the aim of providing clients consistent, accurate and transparent data about the Prague office market.

Acronyms & Abbreviations	
CZGBC	Czech Green Building Council
EU	European Union
MEP	Mechanical, Electrical, Plumbing engineering systems
USGBC	United States Green Building Council
GBCI	Green Building Certification Institute (USA)
BRE	Building Research Establishment (UK)
Code	Base Code Compliant project
Typ. Best	Typical Best Practice project
Green	Green Building project

EXECUTIVE SUMMARY

The overall concept of our study has been to accurately evaluate the actual estimated costs of the construction of a common typology of Green Building relative to the typical local construction means and methods. Recent Czech development can often be divided into its two most prolific categories: basic minimum code compliance and a higher standard of best practice, accepted both here and internationally. It is therefore the two typologies that provide the control relative to third type – the Green Building – for our study.

Each of the designed projects and their respective cost analyses proposes a realistic potential solution as would develop independently to meet a single simple Client Brief, theoretical but in practice common within the current and recent development market of the Czech Republic:

- class A office building of 13,000 m^2 GLA, with ~2,000m^2 floor plates, and 5-7 stories
- on a site of 6,000 m^2, previously developed, bordering the city center, and near public transit
- and providing on-site parking, the opportunity for ground floor retail, and flexible open plan floor plates

Our architecture/engineering teams worked together with cost management, general contractors, and real estate professionals to evaluate the construction and utility operations costs of our three proposed buildings. When reviewing the projected annual utility consumptions of each project, the findings were precisely as expected – similar performance between the CODE and TYP. BEST projects, with almost a 50% reduction for the GREEN project and annual savings of just over 1 million Czech crowns.

On the other hand, when analysing our completed construction costs the data offered a bit of a surprise. The Total Construction costs for the GREEN project actually came in the lowest, very close to the CODE project at about 0.5% lower. The TYP. BEST project was then 7.0% more expensive than both of them. Upon closer examination; however we see that the cost per square meter (GIFA) shows a more linear relationship, and one more in line with common preconception about the costs of these building types. The GREEN was 20,200 czk/m^2; while the TYP. BEST was 19,200 czk/m^2 for a 4.6% savings; and the CODE was 18,500 czk/m^2 for a 8.5% savings relative to the GREEN.

This conventional analysis, while reinforcing some industry preconceptions, ignores one very crucial point – the design brief was to provide a set amount of Net Leasable Area (NLA). By delivering the client requested NLA with a more sustainable solution that required less extra non-leasable floor area, the GREEN project was able to build a building satisfying the client brief with 10% less total area – eliminating the provision of a substantial and costly portion of the underground structured parking due to the site's proximity to public transit. The GREEN project also limited cost by using a less-costly façade with less total glazing, offsetting the projects higher MEP system cost – thus factoring these primary cost differences, the project saves money in the overall total construction costs, even while building at a cost per square meter rate higher than either of the other two projects.

This detailed analysis shows that through using a integrated design process and incorporating a 'green building' approach from the beginning of a project's development, it is possible to build a higher quality building for lower cost that the typically accepted best practice building or even then the minimum code compliant building. While the technology, design expertise, and construction experience of sustainability in the Czech commercial real estate development sector have not yet matured to the level that the international 'best practice' classification has over the last 15 years, it is clear that investment in greener project development does not need to be more costly, and certainly has potential to offer a pleasant return on investment.

1. INTRODUCTION

The financial value of the 'green' building has been at the center of discussion of the construction industry for many years. Although this question has been able to be fleshed out in some western markets – such as in North America, and to a limited extent in some portions of the western European markets – due to the accumulation of historical data from years of on-going completions of construction projects, within central Europe, and in particular, the Czech Republic, insufficiently comprehensive data from the very few realized projects has left a vacuum for any real or reliable data. Ever since the push for a sustainable approach in building became a widespread notion, the debate has grown and has had a major impact on the building market. Yet, the involved parties – developers, investors, occupiers, and contractors – would reason their inability to promote sustainable building and create an endless circle as David Cadman first described in 2000 as seen in Figure 1Table 1.

Figure 1: Vicious circle of blame (Source: www.emeraldinsight.com)

Why such indecision and animosity? This can be attributed to several hurdles that have since been mostly overcome. Firstly, the popular term 'green building' has been clarified. Although it was at first looked upon as a radical notion brought up by minority interest groups, it is nowadays more well-known and perceived as a relatively standard approach to creating a pleasant and healthy environment while adding value to all aspects of sustainability, i.e. the environmental, architectural and social perspectives. Secondly, all parties involved in property development have begun to cooperate in the search for solutions rather than simply avoiding any change to their habits. Thirdly, there has been a strong legislative push for energy savings across several industries that impact how we build. In particular, the EU Directive on the energy performance of buildings has been instrumental in driving change throughout the European region. Finally, customers such as tenant companies in office buildings have started to recognize the advantages of a healthy and comfortable working environment as a competitive business advantage.

Once this willingness to accept the changing market appeared, the economic questions about the pros and cons of the ‘green’ approach quickly arose:

- If sustainability truly is better than the actual standard, is it going to cost more? (and to what do you compare relative costs?)
- If it truly is more costly, how much more? (again compared to what base?)
- Will the investment in green building pay off?
- How long will the payback time be? (and what will impact the return?)

1.1. Significance of existing research

To answer this, relevant research has been carried out abroad where sustainable building has built a longer tradition. The Davis Langdon company (2004) undertook two significant studies, the first one in 2004 and another one in 2006. In the former, 138 buildings in the USA were reviewed. It was found that there was no significant difference in the average costs for green buildings as compared to non-green buildings. Many project teams are building green buildings with little or no added cost, and with budgets well within the cost range of non-green buildings with similar programs. In the latter study, 221 US buildings were analysed and the coming to the same outcome (Langdon, 2007). Similarly, Greg Kats (2003) performed a study of 150 buildings in the US and other countries. He found that green buildings cost approximately 2% more to build than the conventional ones. In addition, green buildings reduce energy use by an average of 33%, resulting in significant operational cost savings. Another report suggests that green certified buildings have an average rental premium of 4-5% (Fuerst & McAllister, 2008). Furthermore, based on a sample of sale prices for 559 Energy Star and 127 LEED-certified buildings, it was found that price premia of 26% and 25% were achieved, respectively; with higher levels of certification delivering higher premia (Ibid.). This is again supported by the outcome of another study that states that, “we find that buildings with a ‘green rating’ command rental rates that are roughly three per cent higher per square foot than otherwise identical buildings - controlling for the quality and the specific location of office buildings. [All things being equal], premiums in effective rents are even higher - above six per cent. Selling prices of green buildings are higher by about 16 per cent.” (Eichholtz, et al., 2009)

These studies share two main parameters. Firstly, they are based on an adequate sample of existing projects where actual realized cost data are available. This is important as only a statistically significant number of projects reviewed can reliably represent the whole of the area studied. Secondly, the researched pool of projects comes from within the same geographic, legislative or demographic area. The reasoning behind this concern is that differences in local conditions can often mean a substantial variation of costs within the building industry. Therefore, the applicability or even reliability of results would be unusable or severely limited if these parameters were overlooked.

It also unfortunately means that these results can be applied to the Czech market only in a limited manner. The lack of a reliable and comprehensive assessment of green buildings specifically addressing the Czech market has been a major obstacle for the implementation of sustainable development practices locally, as investors and financial institutions require reassurance before putting there money into anything that has yet to be proven in the local market.

1.2. Aim and structure of report

The Czech Green Building Council (CZGBC) has recognized the gap in existing research and has chosen to take action to correct the problem. The Costs, Benefits, and Values of Green Building Task Group (Green Value group), consisting of multidisciplinary council members, was created to prepare a professional design and cost study specific to the Czech Republic, which would quantify the differences in the up-front costs, and both the short and long-term values of new green buildings in comparison to typical regional practices.

The study aims to provide a reputable comparison of office building valuation between more sustainable green building practice and typical Czech practices, to guide investors, developers, and lenders during this interim period before more green projects are realized, and actual realized data can be compiled.

Key criteria of the Green Value group's study include:

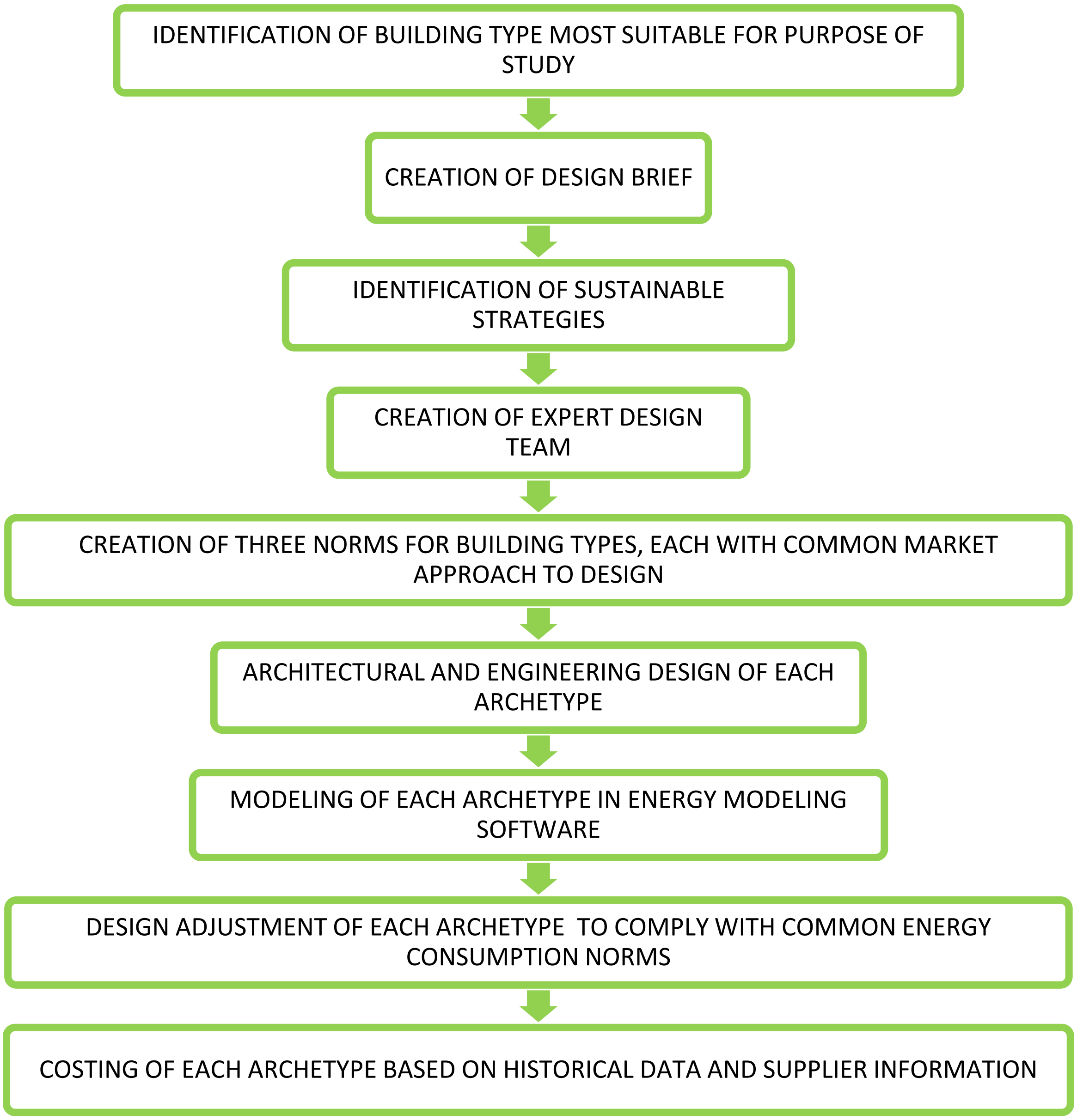
- a realistic review of typical local-specific projects
- a sample of regional-specific design solutions and modifications
- accurate anticipated energy savings, based on regional utility costs
- the estimated effects of green buildings on operating costs
- any expected impacts to the leasing of green office space
- projected resale or long-term value to be created

The first steps of the study serve to describe the methodology, which was developed, including the assumptions, strengths and weaknesses, detailed thinking process, and reasoning for each step. In the next section, the findings of the completed cost analysis are presented and discussed. On this basis, conclusions on the applicability of the study throughout the market are also examined. Finally, supporting detail of the entire works is presented to support our findings.

2. METHODOLOGY

The main focus of the study was to create a comprehensible methodology, which would allow for a reliable and contextual evaluation of construction costs of a green building typical for the Czech market. Another aim was to achieve applicable, easy to understand results based on historical cost data. Therefore, a simple approach was adopted. For illustration, the key steps as drawn in Figure 2 were taken:

Figure 2: Key methodology steps



The aim of the process was to adhere to the local standard professional construction practice. Therefore, the team consisted of experts working on tasks of their specific expertise. Furthermore, they worked independently or in cooperation as they would on a standard client project. The results – costs – of the three archetypes were then compared and analyzed.

The methodology section describes each of the above steps in detail.

2.1. Project management

Creating the design team with great care was vital to ensure that the individual tasks were done by the most appropriate professionals and to secure high credibility of the study. The team was assembled both from the CZGBC volunteers and outside parties. Six separate groups worked on individual tasks as described in Table 1.

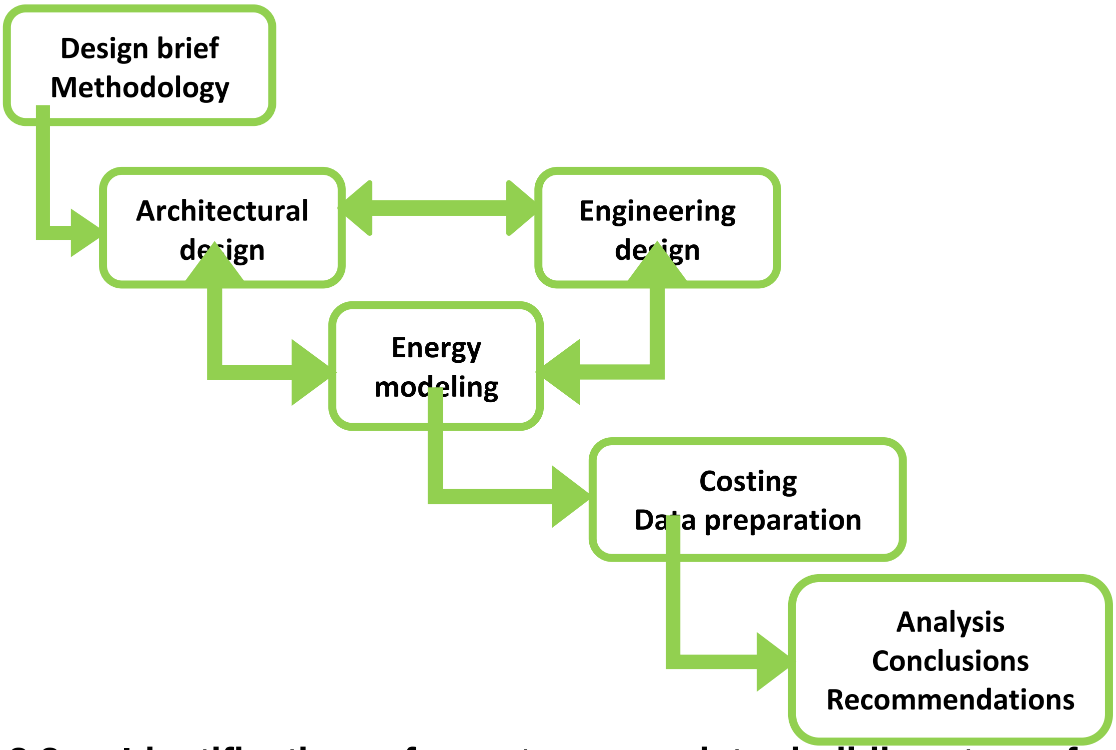
Table 1: List of personnel and tasks

Professionals working on task	Description of task
Cost, Project & Design managers, LEED AP, BREEAM Assessor, Sustainability Consultant	• design brief definition • methodology definition
3 groups of architects	• architectural design of each building
3 groups of engineers	• engineering design of each building
MEP Engineers	• energy modeling
CZGBC council members and independent third party cost professionals from Cost Management, Project Management and construction firms active in the market	• costing of each model building • preparation of data
CZGBC members: Cost, Project and Design Management Professionals External third-party: academic, engineering and design professionals, some of which were highly familiar with all of the relevant green building certification systems, while the others had no such practical experience	• analysis of the data • preparation of the results, conclusions and recommendations

All of the experts familiar with the green certification systems have professional experience on two or more buildings defined as 'green buildings' in addition to their explicit interest in furthering green property development through their membership and activity in the CZGBC. Some of the members are accredited or certified within individual green building certification systems.

Figure 3 illustrates the working system between the above tasks.

Figure 3: Interrelationships between tasks



2.2. Identification of most appropriate building type for evaluation

As the initial step, the most appropriate building type for evaluation was selected. Several types were considered: administration, residential, retail and industrial. The selection was made based on the following criteria:

- level of demand in large Czech cities
- applicability and relevance to the overall Czech building market
- availability of data across the various sectos of the building industry
- potential benefit in promoting the adoption of green building practices in the speculative development market
- demand for sustainable certifications

The Figure 4 and Figure 5 show details of the LEED certified or currently registered projects in the Czech Republic. Based on the data, two of the above criteria can be simply evaluated: the most sought after location and typology. It can be seen that 6 out of 7 and 21 out of 26 certified or registered projects are located in Prague, while at least 26 of the projects are office buildings (the type of 5 projects could not be identified).

Figure 4: Projects LEED certified in the Czech Republic (Source: http://www.gbci.org/main-nav/building-certification/registered-project-list.aspx)

Project Name	City	State	Country	LEED System	Case Study	Owner Organization	Cert Level
			CZ				
CSOB Headquarters	Prague		CZ	LEED NC 2.2	Detail		Gold
City Green Court	Prague	03	CZ	LEED-CS v2009	Detail	Skanska Property Czech Republic	Platinum
Hills Pet Nutrition (Czech Republic)	Hustopece		CZ	LEED NC 2.2	Detail	Colgate-Palmolive	Gold
Jupiter Building Explora Business Center	Prague	03	CZ	LEED-EB:OM v2009	Detail	Explora Jupiter S.r.o.	Gold
Main Point Karlin	Prague	03	CZ	LEED-NC v2009	Detail	PSJ INVEST	Platinum
Qubix 4 Praha	Prague	03	CZ	LEED-CS v2009	Detail	Stavebni A Inzenyrska Spolecnost, Spol.	Platinum
Vysehrad Victoria	Prague	03	CZ	LEED-EB:OM v2009	Detail	Vysehrad Victoria S.r.o.	Gold

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Figure 5: Projects registered for LEED certification in the Czech Republic (Source: http://www.gbci.org/main-nav/building-certification/registered-project-list.aspx)

Project Name	City	State	Country	LEED System	Owner Organization	Detail
			cz			
Administrativni centrum Kacerov	Praha	03	CZ	LEED-CS v2009	Centrum Kacerov Ltd.	
BC Smichov	Prague 5		CZ	LEED-CS v2009		
CB Centrum	Ostrava	05	CZ	LEED-CS v2009	Skanska Property CR	
COPA Centrum Narodni Prague	Prague	03	CZ	LEED-CS v2009	COPA Centrum Narodni, S.r.o.	
City Green Court - Skanska Office	Prague	03	CZ	LEED-CI v2009	Skanska Property Czech Republic	
EAME Overhaul Reman Center	Zatec	03	CZ	LEED-NC v2009	Solar Turbines EAME S.r.o.	
Florentinum	Prague	03	CZ	LEED-CS v2009	Development Florentinum S.r.o.	
Ingersoll-Rand Ovcary	Ovcary At Kolin	06	CZ	LEED-NC v2009	Ingersoll Rand Ovcary	
Jindrich Plaza	Ostrava		CZ	LEED CS 2.0		Detail
Jindrisska 16	Praha	03	CZ	LEED-CS v2009	J.H. Prague A.s.	
Jungmannova 15	Praha	03	CZ	LEED-CS v2009	Jungmannova Estates A.s.	
Lincoln Chodov IV-V-VI	Chodov	08	CZ	LEED-NC v2009	SKF LBU	
Odien Tower North	Praha	03	CZ	LEED-CS v2009	Avia Park II, S.r.o.	
Office Islands - Building A	Praha Letnany	03	CZ	LEED-CS v2009	Hochtief Development Czech Republik s. r	
Office Islands - Building B	Praha Letnany	03	CZ	LEED-CS v2009	Hochtief Development Czech Republik s. r	
Office Islands - Building C	Praha Letnany	03	CZ	LEED-CS v2009	Hochtief Development Czech Republik s. r	
Office Islands - Building D	Praha Letnany	03	CZ	LEED-CS v2009	Hochtief Development Czech Republik s. r	
Office Islands - Building E	Praha Letnany	03	CZ	LEED-CS v2009	Hochtief Development Czech Republik s. r	
Office Islands - Building F	Praha Letnany	03	CZ	LEED-CS v2009	Hochtief Development Czech Republik s. r	
Palac Stromovka	Praha	03	CZ	LEED-CS v2009	Holesovicky Trojuhelnik A.s.	
Q5 Waltrovka Offices	Prague	03	CZ	LEED-CS v2009	Pembroke Jinonice A.s.	
Rustonka A	Praha	03	CZ	LEED-CS v2009	Rustonka Development S.r.o.	
Rustonka B	Praha	03	CZ	LEED-CS v2009	Rustonka Development S.r.o.	
Rustonka C	Praha	03	CZ	LEED-CS v2009	Rustonka Development S.r.o.	
VGP Park Hradek nad Nisou	Hradek Nad Nisou	04	CZ	LEED-CS v2009	VGP - IndustrißlnÝ Stavby, S.r.o.	
VN3 - Diamant	Prague 1	03	CZ	LEED-CS v2009	Redbird, Sro.	

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Based on this, the office building type located in Prague was selected.

2.3. Formulating design brief

The primary objective of the design brief was to determine the common design criteria for a 'typical' Prague office building. This was a complex task as each project differs in the basic specifications such as location, site, size, orientation, shape, access options, building services etc. Further detailed specifications are still more complex and it is not possible to generalize them into one common specification. For these reasons, the locally modified space standards used by the Prague Research Forum given by PEPCIG European Market Standards were used for the brief formulation. Please see Appendix **Error! Reference source not found.** for the Standards.

Consequently, only the basic design criteria were defined as follows:

- Quality of the whole project
- Area of leasable office space
- Number of stories
- Function of the ground floor
- Area, orientation and type of site
- Location
- Public transport and parking availability
- Ground floor plan shape with approximate location of services and leasable areas

As the design brief outline included information useful in evaluating more than just a comparison of cost and modeled energy consumption, its secondary objective was to evaluate the durability and lifespan of equipment and systems (maintenance and replacement costs) and efficient use of the buildings (operating costs) accounted for in the cost analysis.

2.4. Design brief

Based on the criteria specified in Section 2.3, the following design brief was devised.

Provide 13,000m^2 of leasable 'Class A' speculative office space in a new 5-7 story office building. The ground floor of the building should include the possibility for some mixed-use leasable space for service or retail, through flexibility of the design.

The building will fit one of the three defined building types: Base Code Compliant, Typical Best Practice, and Green Building. The issued Sustainable Building Strategies document details the individual strategies that each building type should incorporate.

The project is to be located on a 6,000m^2 previously developed site located in the 1km wide band surrounding the 2km diameter Prague city center. This "City Center Edge" zone is typical of multiple project sites anticipated to be redeveloped in the near future. The site is approximately 200m from public transit access, which gives the project a reduced parking requirement (estimated to be approximately 1 space per 80m2). The site is oriented in a direct East-West orientation, 65m x 92.3m and adjoined on the west border by a local public road.

Class A definition reflects an above average property in the market with quality criteria being at the upper end of the scale. (Class B would represent the average or typical property.) To be classified as Class A, the project must satisfy 5 or more of the following "Hard Criteria" and at least 5 of the "Soft Criteria".

Hard Criteria:

- Modern cable management

- One of the following: raised floors / suspended ceilings with power poles or cable trays / compartment trunking / provision for under-floor cabling
- Modern air handling system
- Adequate provision of secure dedicated car parking
- Premium building location
- 24-hour access and security
- A high quality standard finish
- Modern high-speed elevators, maximum waiting time of about 30 seconds
- Air conditioning system with humidity control

Soft Criteria:

- Clear ceiling height of at least 2.65m
- Prestige / quality reception area
- Flexible design partitioning
- Sufficient lighting
- Sprinkler system / Fire security
- Good accessibility
- Public transport, in addition to car accessibility
- Services in the building / immediate vicinity

2.5. Determining sustainable strategies

Fifty seven sustainable strategies were defined to understand the 'environmental' or 'green' character of the three solutions. The sustainable strategies share common themes with some of the more popular sustainable building certification systems, such as LEED, BREEAM and SBTool. However, the ambition was to meet the local standard practice for energy efficiency and other environmental concerns rather than explicitly setting certification targets for the proposed solutions and evaluating them according to the aforementioned certification systems.

The strategies then served as the basis for evaluating the three archetypes. However, the extent to which they were accomplished was not examined as this was tertiary to the study. The strategies were categorized as follows:

- Pre Design

e.g. Integrated Design, Building Geometry, & Site Location

- Site Impact

e.g. Pervious Paving, Reduced Parking, & Bicycling Infrastructure

- Design Impact

e.g. Glazing Ratio, External Shading, Landscaping ,& Green Roofs

- Energy Performance

e.g. Performance Targets & Building Commissioning

- MEP Systems

e.g. Ventilation Strategy, Stormwater Management, HVAC

- Construction Process

e.g. Construction Waste Recycling, Construction Waste Landfill Diversion

- Post Occupancy

e.g. Occupant Education, Optimization of Use

2.6. Definition of three archetypes

Recent Czech development can often be divided into 2 categories: basic minimum code compliance and a higher standard of best practice. It is therefore the two typologies that provide the control for the study, i.e. to the green archetype. The proposed three types are

1) Base Code Compliant
2) Typical Best Practice
3) Green

For clarity, the following font colors and abbreviations will be used for the types throughout the report:

CODE	TYP. BEST	GREEN

All design development members collaborated to define the extent of the Sustainable Strategies to which each typically applies to the three building typologies in our market. The aim of each extent was to prepare foundation for a realistic design solution that could be developed to meet a simple client brief, theoretical but common in practice.

2.7. Architectural and engineering solution of each archetype

The three independent design teams consisting of architects and engineers developed each design solution. Each team applied the complete list of the Sustainable Strategies as relevant to their particular archetype at their discretion within the outlined guidance of the study.

An integrative review procedure was in place during the design development. Reviews of each architectural and engineering solution were undertaken twice at the minimum. All design team members together with the Task group chairmen appraised the proposals to ensure that the project brief was met to allow for direct comparison of the archetypes and avoid any significant anomalies in the cost evaluation. Any issues were raised and addressed by the design teams in much the same as requests for clarification and addenda to the project brief are resolved in a standard competitive bid tender procedure.

The basic building specifications for the Code, Typ. Best and Green archetypes are summarized in Table 2 and Figure 6, 7 and 8. Detailed specification is available in Appendix **Error! Reference source not found.**. The black color denotes the Code type, blue is for Typ. Best and green for the Green building. The Code building was used as the basis for the Typ. Best and Green building standard.

Table 2: HVAC specification for each type

	Code	Typ. Best	Green
Ventilation	Natural & Mechanical	Mechanical	Combined Natural & Mechanical
Cooling	Scroll compressor	Air-cooled chiller	Thermal heat pump reverse cycle & air-cooled chiller
Heating	Municipal heating network	Condensing boiler	Thermal heat pump & Municipal heating network

The selection of simple MEP systems for the Base and Typ. Best archetypes are indicative of the trends in the market. The Green solution steps away to an alternate solution, yet one that again has found commercial acceptance within the market. Other more unique or innovative MEP solutions were not selected as they were deemed irrelevant for our 3-part archetype comparison at this time.

Figure 6: Architectural specification for Base Code Compliant building

CODE

The **CODE** solution is seen as the low-cost building option indicative of projects where minimizing capitol investment is the Client's highest concern. Technologies and design solutions are utilized **ONLY** to meet minimum code compliance, with **NO** or little effort to provide **ADDITIONAL** design or equipment **EFFICIENCY**.

Areas;
Typ. Floor; GIF: 2,850m² / NLA: 2,250m²
Total; GIF: 22,097m² / NLA:13,365m²

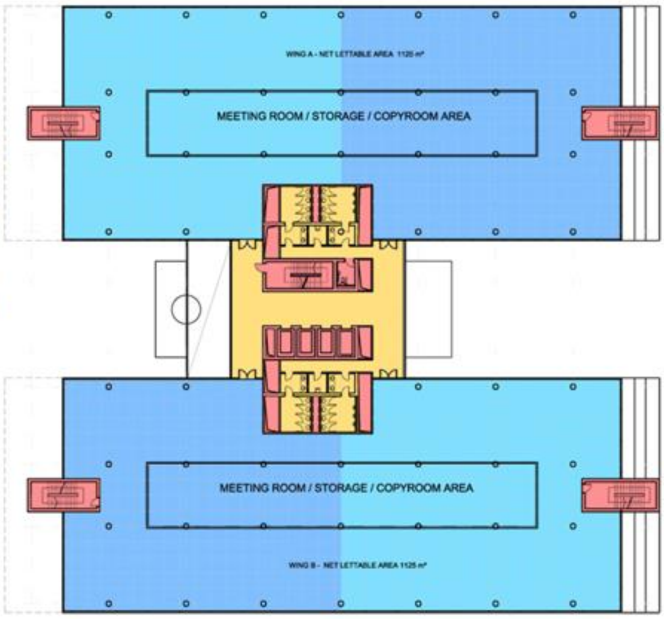


Figure 7: Architectural visualization for Base Code Compliant building

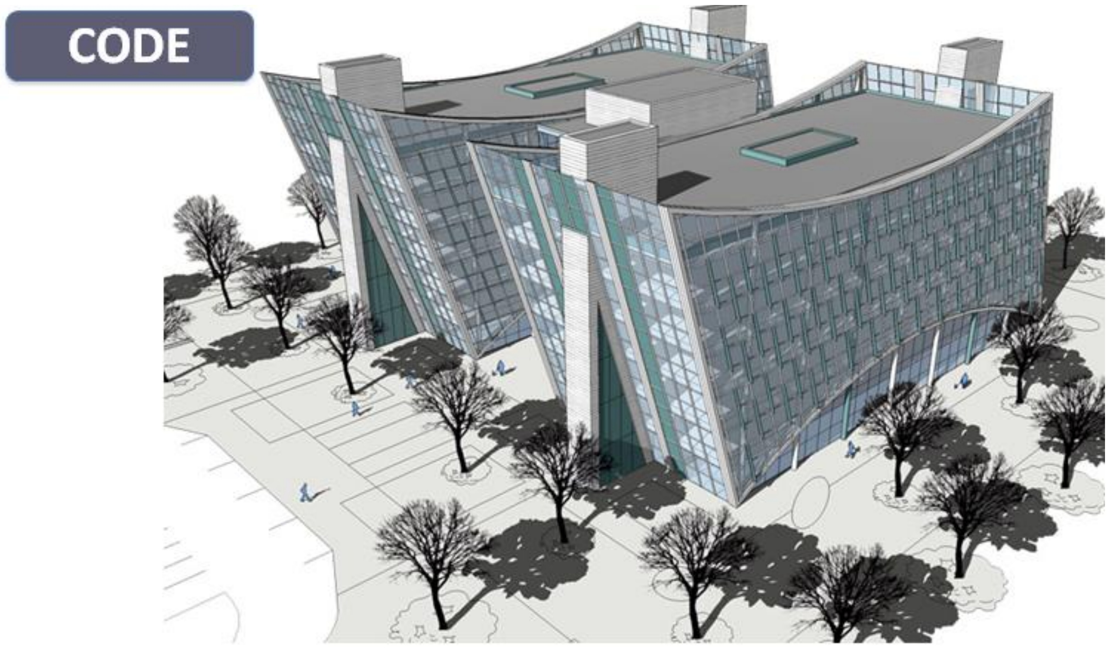


Figure 8: Key features of the Base Code Compliant building

Figure 9: Architectural specification for Typical Best Practice building

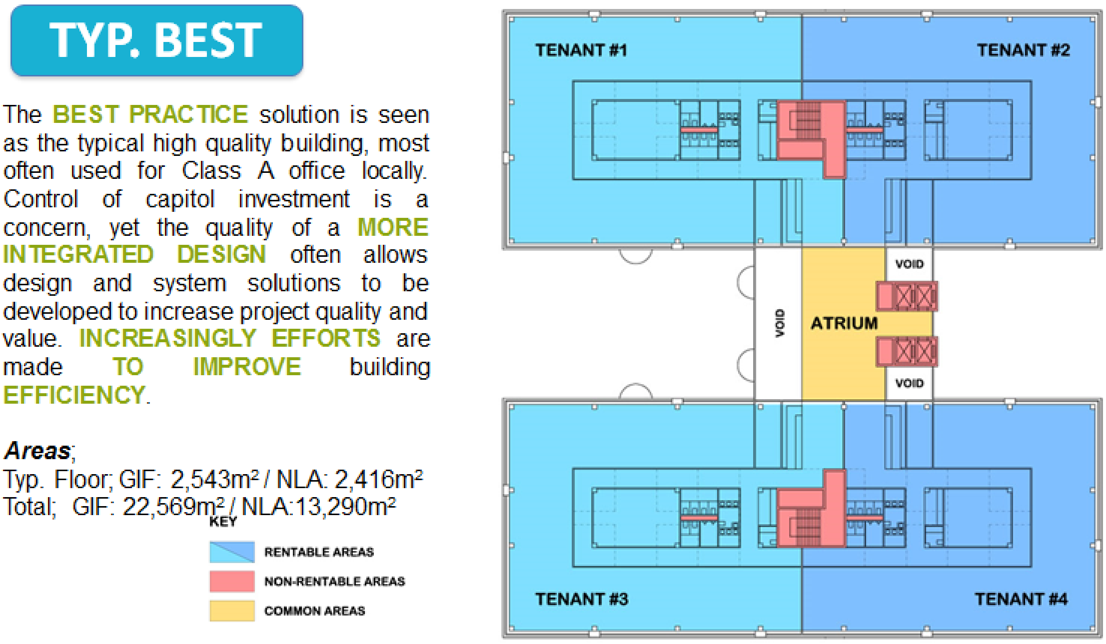


Figure 10: Architectural visualization for Typical Best Practice building

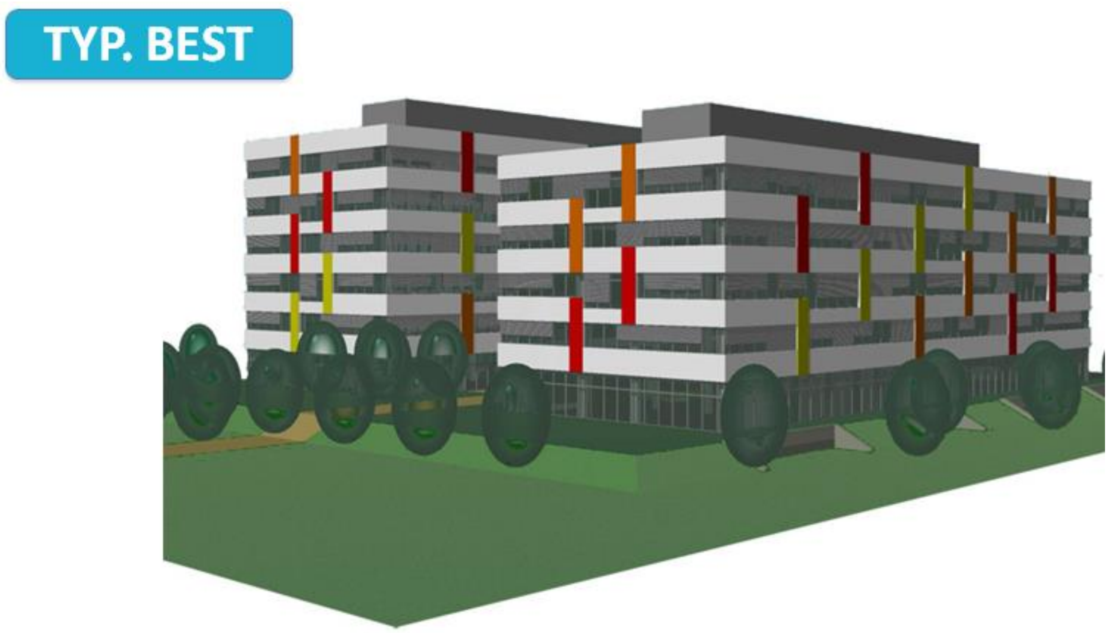


Figure 11: Key features of the Typical Best Practice building

Figure 12: Architectural specification for Green building

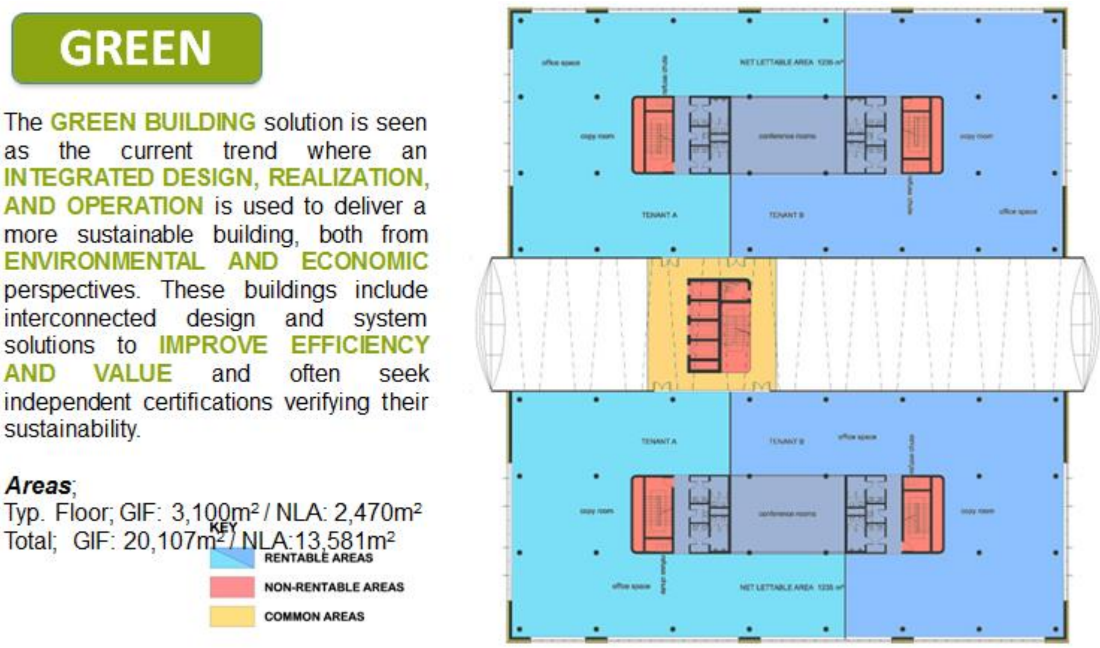
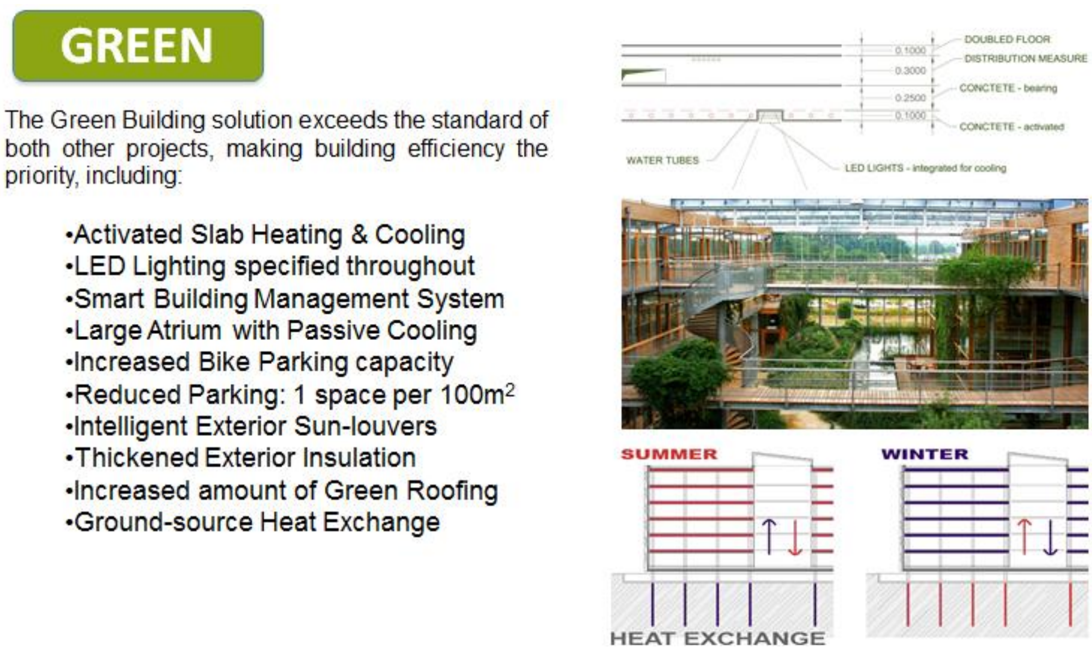


Figure 13: Architectural visualization for the Green building

Figure 14: Key features of the Green building



2.8. Energy modeling

To gain energy performance data, each archetype was modeled in an energy evaluation software ‘Energie 2009’. Each model included the designed engineering and architectural specifications. The modeling was completed primarily by the Mechanical, Electrical and Plumbing (MEP) teams; however, each architectural team coordinated closely with their respective engineering team to ensure the accuracy and completeness of the energy simulation, especially the inputs and outputs.

Selected unit input values (Table 3) such as heat gains per person or meter square of glazing were identical across the archetypes.

Table 3: Selected energy modeling input values

Input	Unit	Value
Internal heat gains	W/m2	
- Occupants		5.3
- Appliances		15
- Lighting		7 (average value)
Lighting on	hours	
- during day		2250
- during night		250
Window frame reduction	unitless	0.95
Temperature setpoints	^{o}C	
- Heating		20
- Cooling		26

Following the first modeling outcomes, the archetype designs went through an adjustment process to achieve energy consumption data in line with the standard real-life data representative of each archetype. This was performed through the ‘trial and error' process, when individual construction elements were adjusted until the realistic results were achieved.

2.9. Cost evaluation

After the designs had been finalized, the costs of each were calculated. Two types of costs were assessed: construction and operation. The former was based on unit prices for each portion of the project and included direct and indirect building construction costs. The values used were based on local long-term historical data available to the Cost Expert and professional experience. The operation costs included expenses related to running the building services supplying energy for domestic hot water, heating, ventilation cooling, and lighting. The final costs were then compared between the archetypes in terms of total investment expenses and annual expenses.

The construction costs have been derived using the task group project information and historical cost data available from similar office projects. As this is a preliminary analysis based on parametric data, these figures should be used with caution and are more useful as a comparison between options rather than an absolute indication of probable construction cost.

The cost model includes all direct and indirect building construction costs normally identified by design documents.

It specifically excludes the following:

- Planning and administrative costs
- Land Acquisition Costs
- Professional Fees & Development Costs:
- Financing Costs, Interest, Loan Fees
- Developer Profit
- Legal fees and expenses
- Permits
- Development cost charges
- Loose furnishings and equipment
- Removal of hazardous materials
- Demolition and alterations

- VAT
- Escalation
- Contingencies
- Tenant Fit Out

The cost model has been prepared using historical costs per Gross Floor Area cost data available from similar type projects. The Gross Floor Areas were measured from the drawings produced by the architectural team. The construction costs of the three options have been developed by applying unit rates per gross floor area to their respective floor areas on an elemental basis.

Further adjustments have been made to the elemental unit rates on several building elements to take into consideration the varying scope of work for the following items:

- Parking Area
- Building Envelope
- Exterior Blinds
- Lighting Systems
- HVAC Systems

The cost plan reflects current rates taking into account the size and nature of the project. The unit rates utilized are considered competitive for a project of this type, bid under a stipulated lump sum form of tender in an open market, with a minimum of five bids, supported by the requisite number of sub-contractors. The cost model developed is applicable to office building projects in the Prague, Czech Republic area.

The estimated cost is based on the following information:

- Research Project Design Brief
- Sustainable Strategies Summary
- Archetype 1: Base Code Compliant project
- Archetype 2: Typical Best Practice project
- Archetype 3: Green Building project

- Historical cost data of similar type projects

Strengths and limitations

There were two main aims of the methodology: to emulate the real design and cost management process in the Czech Republic, and to be simple and comprehensible. It involved industry professionals with excellent expert knowledge. Another strength was using long-term historical cost data. This approach ensured that the outcomes are easy to understand especially to the target audience, specific and applicable to the Czech building market, and highly reliable.

However, the study could not avoid the following limitations:

- As there is not an adequate number of the three office buildings archetypes built in the Czech Republic, the work is based on theoretical models.
- The models represent the most common approach to office buildings in the Czech Republic but, in reality, there is high diversity of specifications among individual projects.
- Inclusion of a limited number of MEP solution scenarios may have restricted the results of the study

3. RESULTS AND DISCUSSION

The results of the cost evaluation are presented and analyzed here below. The analysis is divided into four categories – total actual costs, forecasted operational costs, and costs relative to net leasable area and costs relative to gross internal floor area. Based on the outcomes of the study and our review of these four sections, we present the feasibility of the Czech construction market 'going green'. All costs are given in Czech crowns.

3.1. Total costs

This series of data presents the summary breakdown of the total estimated costs of the three complete archetypes, as designed by our task group design professionals. The area summary table below serves to show the relative size similarities and differences between the three designed archetypes. It should be noted that the design brief required a building to be completed providing a net leasable are (NLA) of 13,000m^2. It was somewhat at the discretion of the design teams and the technical requirement of their architectural and MEP system designs, as well as their provision for parking, that would ultimately determine the overall total building size, which is most often represented by gross internal floor area (GIFA). It can also be seen that due to the more 'sustainable' solution of the GREEN project, which includes less parking, their project has almost 10% less GIFA, which will impact pricing analysis.

AREA SUMMARY OF BUILDING WORKS - ACTUAL AS DESIGNED

DEFINITION OF AREAS	Areas in Square Meters (CODE) m2	Areas in Square Meters (TYP. BEST) m2	Areas in Square Meters (GREEN) m2
NLA	13,365	13,290	13,581
GIFA	22,097	22,569	20,107
GEFA	22,282	22,685	20,897

When reviewing the actual calculated cost estimates below several key point shall be noted. The most obvious point is that the total construction costs figures indicate the GREEN project as the lowest cost, very close to the cost of the CODE project, while the TYP. BEST project is approximately 7% more costly. Further review of the figures indicates that major cost differences exist in several of the presented cost groups. In the substructure, the reduction of underground structured parking in the GREEN project results an a substantial reduction of construction costs. In the FFE group the GREEN project greatly exceeds the costs of the other buildings due to its integration of several more complex and advanced technical equipment solutions, such as its automatic external sunblinds. Here also there can be seen a measureable difference between the CODE and TYP. BEST projects due to added complexities of the higher quality specification. This relationship is repeated again in the Services cost group to a more linear increase across the archetypes, as the more complicated MEP systems of the higher standard buildings incur additional construction costs. Notably also is the reduction of costs in the External Works cost group where the lower impact hardscaping and landscaping of the GREEN project, together with the elimination of artificial irrigation systems, again result in reduced construction costs.

COST ESTIMATE OF BUILDING WORKS - ACTUAL AS CALCULATED

COST GROUP / ELEMENT GROUP	TOTAL COST OF ELEMENT (CODE) CZK	TOTAL COST OF ELEMENT (TYP. BEST) CZK	TOTAL COST OF ELEMENT (GREEN) CZK
SUBSTRUCTURE	75,127,200	72,908,250	45,917,550
SUPERSTRUCTURE	170,374,990	182,208,400	155,095,550
INTERNAL FINISHES	38,275,940	37,615,250	39,678,480
FITTINGS, FURNISHINGS & EQUIPMENT (FFE)	905,000	1,205,000	9,673,000
SERVICES	103,389,780	119,480,700	136,823,876
EXTERNAL WORKS	4,143,740	4,167,700	2,782,140
MAIN CONTRACTOR'S PRELIMINARIES	15,688,666	16,703,412	15,598,824
TOTAL: BUILDING WORKS ESTIMATE (A)	407,905,316	434,288,712	405,569,420
Net Difference to GREEN	+0.58%	+7.08%	

3.2. Operational costs

When analyzing the forecast energy consumptions of the three archetypes based on the energy modeling, the great operational savings of the GREEN project are apparent. By incorporating more advanced or at some points simply less complicated MEP systems and a more effectively insulated building envelope, the GREEN project was able to greatly reduce energy demands. The GREEN project achieves heating and cooling energy reductions of 20-50% relative to the other projects, domestic hot water energy reduction of 80%, and a general lighting consumption reduction of 45-55%. Even while including the same anticipated tenant/user/occupant energy consumptions for all three projects, which can account for more than 35% of a buildings total consumption, the GREEN project was still able to drastically reduce forecast annual energy consumption.

FORECASTED ANNUAL UTILITY OPERATIONAL COSTS

ANNUAL UTILITY CONSUMPTION	TOTAL COST OF UTILITIES (CODE) CZK	TOTAL COST OF UTILITIES (TYP. BEST) CZK	TOTAL COST OF UTILITIES (GREEN) CZK
TOTAL: COMBINED ELECTRICAL & GAS	3,638,252	3,719,910	2,467,127
Annual Cost Difference relative to GREEN	+1,171,125	+1,252,783	
Net Difference to GREEN	+47.47%	+50.78%	

3.3. Relative Cost On the Basis of a Target GIFA

A traditional analysis of the costs of these three projects using the predominant real estate market measure of the ratio of cost per square meter of gross area (cost per m^2 GIFA), reveals the preconceptions about green building held by many in our market. The figures below show a quite linear progression from what is perceived as the lowest acceptable quality CODE project, up to the standard TYP. BEST project, and then topped of by the high quality GREEN project. This cost premium of 4.5-8.5% over the two other archetype solutions supports the idea that the more complex and advanced the architectural and engineering solutions, the higher the associated construction costs. What is of course also worth noting – and which leads to the overall lower Total Cost indicated above and the lower cost per m^2 NLA – is the fact that while the actual GIFA of both the CODE and TYP. BEST projects sit very close to a typical target of 22,000m^2, the GREEN project met the project requirements with a significantly lower gross area (GIFA).

RELATIVE COST – BASED ON THE TARGET GIFA OF 22,000 m^2

DEFINITION OF AREAS	Areas in Square Meters (CODE) m2	Areas in Square Meters (TYP. BEST) m2	Areas in Square Meters (GREEN) m2
actual GIFA	22,097	22,569	20,107
Target GIFA	22,000	22,000	22,000
Net Change from Target	0.44%	2.59%	-8.60%
RELATIVE COST ESTIMATE - BASED ON TARGET GIFA			
Net Difference to GREEN	-8.48%	-4.60%	
COST RATE per sqm GIFA	18,460	19,243	20,171

3.4. Relative Cost On the Basis of the Design Brief NLA

This series of data presents an important perspective on the true value of the sustainable development solutions and the practice of green building. While traditional estimates and comparisons of the costs of a real estate projects relative to other comparables in the market most often use the ratio of cost per square meter of gross area (cost per m^2 GIFA), that analysis misses a key issue. Since the GREEN project met the client-required design brief while providing less structured parking, its overall gross area (GIFA) is measurably different. As net leasable area (NLA) was the client requirement, and the basis for which the owner will earn income on the property, we include herein a non-traditional review of the ratio of cost per square meter of net leasable area (cost per m^2 NLA), so that this important relationship can be better understood.

This data begins to explain more clearly why and how the GREEN project actually has a lower Total Construction Cost, even though it is providing what are essentially more complex and advanced technical building systems. The total construction costs were compared proportionally to the achieved NLA. It can be seen that each of the three projects provided slightly more NLA then the design brief, yet all within about 2% of each other.

Even though the GREEN project is more costly per m^2 GIFA, as we have seen above, by requiring less total area to satisfy the client brief, its cost per m^2 NLA is actually the lowest of the three projects by a measurable margin.

RELATIVE COST – BASED ON THE DESIGN BRIEF OF 13,000 m^2 NLA

DEFINITION OF AREAS	Areas in Square Meters (CODE) m2	Areas in Square Meters (TYP. BEST) m2	Areas in Square Meters (GREEN) m2
actual NLA	13,365	13,290	13,581
NLA of Design Brief	13,000	13,000	13,000
Net Change from Design Brief	2.81%	2.23%	4.47%
RELATIVE COST ESTIMATE - BASED ON DESIGN BRIEF NLA			
Net Difference to GREEN	+6.60%	+9.43%	
COST RATE per sqm NLA	30,520	32,678	29,863

4. CONCLUSION

Through our study it can be clearly seen that constructing a Green Building can very realistically be done at or below the cost of the common Minimum Code or typical Best Practice typologies. While many of the key players in our market and our profession globally have the preconception that building sustainable buildings is prohibitively expensive, it needs to be understood that commercially viable sustainable real estate development exists worldwide and can easily be developed here in the Czech Republic.

From the beginning of our research, the concept of our study has been to accurately evaluate the actual estimated costs of the construction of a commercially viable Green Building relative to the typical local development solutions. By comparing cost to Czech development's two most prolific categories – basic minimum code compliance and a higher standard of best practice – we have been able to concretely show the impact of a sustainable solution with our study.

The outcomes of our study provide clear support of the affordability of Green building, but it is important to note that our findings are restricted to some extent due to the limitations of our analysis. As there is not an adequate number of actual realized office buildings built in the Czech Republic and fitting into our three characterized typologies to utilize their real development costs, our research has been required to be based on theoretical models. The archetype models also represent only a single, although very common type of building and the most common development approaches to this building type in the Czech Republic; but, in reality, there is great diversity of project brief and specification among individual projects within the market. By being able to select only a single scenario of complete MEP solutions for our GREEN project we have possibly been limited in our ability to show the applicability of affordable sustainable solutions beyond those described.

Our architecture/engineering teams worked together with cost management, general contractors, and real estate professionals to evaluate the construction and utility operations costs of our three proposed buildings. When reviewing the projected annual utility consumptions of each project, the findings were precisely as expected – similar performance between the CODE and TYP. BEST projects, with almost a 50% reduction for the GREEN project and annual savings of just over 1 million Czech crowns.

On the other hand, when analyzing our completed construction costs the data offered a bit of a surprise. The Total Construction costs for the GREEN project actually came in the lowest, very close to the CODE project at about 0.5% lower. The TYP. BEST project was then 7.0% more expensive than both of them. Upon closer examination; however we see that the cost per square meter (GIFA) shows a more linear relationship, and one more in line with common preconception about the costs of these building types. The GREEN was 20,200 czk/m^2; while the TYP. BEST was 19,200 czk/m^2 for a 4.6% savings; and the CODE was 18,500 czk/m^2 for a 8.5% savings relative to the GREEN.

This conventional analysis, while reinforcing some industry preconceptions, ignores one very crucial point – the design brief was to provide a set amount of Net Leasable Area (NLA). By delivering the client requested NLA with a more sustainable solution that required less extra non-leasable floor area, the GREEN project was able to build a building satisfying the client brief with 10% less total area – eliminating the provision of a substantial and costly portion of the underground structured parking due to the site's proximity to public transit. The GREEN project also limited cost by using a less-costly façade with less total glazing, offsetting the projects higher MEP system cost – thus factoring these primary cost differences, the project saves money in the overall total construction costs, even while building at a cost per square meter rate higher than either of the other two projects.

This detailed analysis shows that through using a integrated design process and incorporating a 'green building' approach from the beginning of a project's development, it is possible to build a higher quality building for lower cost that the typically accepted best practice building or even then the minimum code compliant building. While the technology, design expertise, and construction experience of sustainability in the Czech commercial real estate development sector have not yet matured to the level that the international 'best practice' classification has over the last 15 years, it is clear that investment in greener project development does not need to be more costly, and certainly has potential to offer a pleasant return on investment.

4.1. Further Study

Following our review of our investigations two important topics arose, which warrant further research. First, due to the limiting restraints of our study we were unable to sufficiently review the cost impact of many innovative and perhaps significantly more efficient MEP systems. In providing two archetypes that used the engineering solutions that are typical in projects at this time, our GREEN project was only able to select one set of MEP system solutions, and in order to emphasize the cost parity with the current development trend, they couldn't be anything that would be assumed to incur significant additional cost, even if they would measurably decrease energy consumptions or increase lifespan. A further review of the application of other MEP systems found to be successful, efficient, and commercially viable in other markets, and how they could be applied locally be explored would provide not only a useful resource for local development teams, but could also open up a discussion generally oh how best to bring innovative systems and solutions to our market.

Secondly, analysis of the cost impacts of individually selected alternate systems could be also undertaken. While it is indeed critical to understand and appreciate the interdependence of many of the systems and characteristics of a high-efficiency sustainable building, and how they should inform the design of the building as a whole from the earliest stages, there is great demand in the local market to weigh the advantages of selecting one innovative system versus another. Although such study would be complicated to perform while maintaining accuracy and consistency, these obstacles can surely be overcome through careful planning of the study. Much of the market transformation at this time in the Czech Republic consists of projects, which have been in the development process for many years and are then modified in the late design stages to include more sustainable strategies. It would thus greatly benefit such developments to have a reliable review to help them determine the cost and rate of return on investment if they were to incorporate such technologies as vegetated rooftops, photovoltaic power generation, electric car charging stations, rainwater collection for irrigation or flushing systems, variable air volume or chilled beam HVAC systems. If for no other reason than to show the impact of system interdependence, the complication of weighing one individual sustainable strategy against its conventionally alternate solution would certainly warrant further and detailed study focused exclusively, and would provide a valuable reference to the Czech development market.

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