Investment opportunities in green technology real estate projects

By

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ABSTRACT

The real estate sector accounts for more than a third of global greenhouse gas emissions and potentially provides great opportunity for carbon reduction. Energy efficient and green buildings have a huge potential in transforming the property sector, and investors could benefit from that transformation through the greening of their real estate holdings and investing in green technology real estate developments. My work will further define this opportunity by investigating the real estate industry’s relationship to sustainability and global greenhouse gas emissions through perspective of energy markets, demographical changes and different technologies in the energy efficiency sphere. Additionally my thesis will provide summary of research regarding willingness to pay for efficiency and sustainability measures both in the residential and commercial part of the market. Finally I will analyze main factors affecting demand and forces shaping investment opportunity.

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Title: Senior Lecturer
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# Table of Contents

The real estate industry’s relationship to sustainability and global greenhouse gas emissions 6  
Energy outlook ....................................................................................................................... 6  
People and buildings .......................................................................................................... 9  
Greenhouse gas emissions .................................................................................................. 10  
Summary .............................................................................................................................. 13  

Customer perspective .................................................................................................. 19  
Residential buildings ...................................................................................................... 19  
  Willingness to pay for energy-saving measures and sustainability in residential buildings... 20  
Commercial buildings .................................................................................................... 22  
  Sustainability assessment tools ....................................................................................... 23  
  Does it pay-off .................................................................................................................. 26  
Main factors affecting the demand .................................................................................. 27  
  Marketplace perspective ................................................................................................ 27  
  Social perspective ............................................................................................................ 31  
  Regulation ....................................................................................................................... 34  

Conclusion ....................................................................................................................... 37  

Bibliography ..................................................................................................................... 40
The real estate industry’s relationship to sustainability and global greenhouse gas emissions

Energy outlook

When analyzing different reports regarding energy outlook and related environmental consequences you could observe general trend showing that both energy consumption and emissions of CO₂ will be increasing in the coming years. According to the analysts from the U.S. Energy Information Administration (EIA), the world energy consumption will increase across all fuel sources through 2035 (Fig 1). Most of the growth accounts for an increase in the non-OECD countries, while energy consumption in OECD countries is expected to be stable according to the forecast. Although liquid fossil fuels will remain the leading source of energy their share will decrease by 5% between 2008-35 mainly due to rising oil prices. Renewable energy sources are said to be the fastest growing source and are expected to cover 14% of the world energy consumption in 2035 as compared to 10% in 2008 (Fig 2).¹

Fig. 1 World energy consumption, 1990-2035 (quadrillion Btu)

Source: The International Energy Outlook 2011, EIA

Analysts from International Energy Association (IEA) have reached similar conclusions. According to the recently published World Energy Outlook 2011, the world energy demand will increase by 40% between 2009 and 2035.\(^2\)\(^,\)\(^3\) The fossil fuels participation could decrease by 1% or even 19% in the analyzed period depending on the scenario and impact of energy and environmental policies (Fig. 3).

Fig. 3 World primary energy demand by fuel and scenario (Mtoe)

<table>
<thead>
<tr>
<th></th>
<th>1980</th>
<th>2009</th>
<th>2020</th>
<th>2035</th>
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<tr>
<td>Coal</td>
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<td>703</td>
<td>929</td>
<td>1,212</td>
</tr>
<tr>
<td>Hydro</td>
<td>148</td>
<td>280</td>
<td>377</td>
<td>475</td>
</tr>
<tr>
<td>Biomass and waste</td>
<td>749</td>
<td>1,230</td>
<td>1,495</td>
<td>1,911</td>
</tr>
<tr>
<td>Other renewables</td>
<td>12</td>
<td>99</td>
<td>287</td>
<td>690</td>
</tr>
<tr>
<td>Total</td>
<td>7,218</td>
<td>12,132</td>
<td>14,769</td>
<td>16,962</td>
</tr>
</tbody>
</table>

Source: World Energy Outlook 2011, IEA


\(^3\) Under New Policies Scenario presented in the World Energy Outlook 2011
When looking into the consumption by sector you could observe that the building's sector energy consumption is in line with general trends. According to EIA analysts energy use in residential buildings will increase by 1.1% per year\textsuperscript{4}. Most of the growth accounts for increase in non-OECD countries where improving economic conditions results in higher standards of living and correlated replacement of nonmarket energy sources such as wood and waste which were not fully included in the energy consumption estimates. Residential energy consumption in non-OECD countries rises by 1.9% per year while in OECD countries by 0.3% per year. This discrepancy could be further explained by well-established patterns of residential energy use in OECD countries combined with slower population growth and aging population. Similar trend could be observed in the commercial buildings sectors where growth in energy consumption is estimated at 1.5% per year with 2.8% and 0.8% in non-OECD and OECD countries respectively. Growth disparity stems from above mentioned demographical trends and persisting efficiency improvements in OECD countries.\textsuperscript{5} Estimates provided by IEA analysts (Fig. 4 and Fig. 5) are in line with EIA expectations in the buildings sectors. New-build in non-OECD countries, particularly India and China, is the main driver of 34% growth in global energy demand.

Fig. 4 World primary energy demand by fuel and sector, 2035

\begin{center}
\includegraphics[width=\textwidth]{fig4.png}
\end{center}

\textsuperscript{*}Other includes other energy sector, agriculture and non-energy use.

Source: World Energy Outlook 2011, IEA

\textsuperscript{4} EIA 2011 Reference case; 2008-2035 estimates
\textsuperscript{5} U.S. Energy Information Administration, op. cit.
People and buildings

Population growth is one of the key drivers in the future energy trends. According to the recent United Nations projections the current world population of almost 7 billion is estimated to reach 10.1 billion until 2100 and 9.3 billion in 2050. The growth and distribution of the population is not consistent among different countries. 37% of population is currently living in China and India with further eight countries standing for 22% of world population. According to the expectations relatively higher growth rate will be observed in developing countries. By 2050 five and by 2100 nine least developed countries will be among the twenty most populous countries in the world. Highest growth will be concentrated in a few countries that are expected to represent 50% of the projected population growth - India, Nigeria, Pakistan, the United Republic of Tanzania, the United States, Democratic Republic of the Congo, Ethiopia and Philippines. Population distribution, urbanization and migration trends should also be taken into account when analyzing the buildings sector prospects. Currently more people live in urban than in rural areas and population growth combined with migrations will strengthen this trend in the next 40 years.

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6 USA, Indonesia, Brazil, Pakistan, Nigeria, Bangladesh, the Russian Federation and Japan
Urban population is projected to double with most of the growth taking place in developing countries rather than developed, where urban dwellers will grow 22% by 2050.\(^8\)

![Fig. 6 Percent population growth in urban areas, 2000-2050](image)

Source: Institute for building efficiency, *Driving transformation to energy efficient buildings*

**Greenhouse gas emissions**

When analyzing building sector and green solutions it is essential to understand the consequences of increased green house gas (GHG) emissions and the linkage to the sector. From the global perspective, according to the Intergovernmental Panel on Climate Change (IPCC), *most of the observed increase in global average temperatures since the mid-20\(^{th}\) century is very likely due to the observed increase in anthropogenic GHG concentrations*. Not surprisingly there is an increasing pressure and numerous initiatives supporting reduction of GHG. For example in the European Union 20% emission reduction is

targeted before 2020\textsuperscript{9} with further reductions up to 30% paralleled with commitments from other countries with high emissions.\textsuperscript{10} The importance of policy change is reflected in the Greenhouse Gamble wheels introduced by MIT Joint Program on the Science and Policy of Global Change (Fig. 7).

Fig. 7 Greenhouse Gamble wheels

![Greenhouse Gamble wheels](image)

Source: MIT Joint Program on the Science and Policy of Global Change

Wheels were developed to illustrate uncertainty in the climate change prediction. The roulette style wheels express the change in the global mean temperature over next 100 years, where the size of each coloured slice represents the estimated likelihood of the temperature change. The “No policy” wheel was created assuming that no actions would be taken to limit the global emissions of greenhouse gases while “With policy” wheel case assumes that taken actions would result in the stabilization at 660 ppm-equivalent of CO\textsubscript{2}. Through comparison of the two wheels you could observe the change in the size of the temperature slices that represents changing probabilities when switching from a "No policy" case to a "With policy" case. One of the key observations is that introducing policies to reduce greenhouse gas emissions results in 90% likelihood of limiting temperature change in 2100 to below 3°C when compared

\textsuperscript{9} Compared to 1990 levels
to the "no policy" case thus showing the importance of the issue.\textsuperscript{11} Owing to such initiatives the level of carbon dioxide, which constitutes the largest part of the greenhouse gases is closely monitored. According to the OECD research, global emissions of CO\textsubscript{2} have been rising on average by 2\% per year since 1971 with estimated further growth of 39\% by 2030, 1.4\% on yearly basis. As of 2007 OECD countries were responsible for 45\% of emissions and are projected to account for 31\% in 2030. Decrease in mainly due to rapid growth in developing countries, particularly in China.\textsuperscript{12}

When analyzing CO\textsubscript{2} emissions from the sectors perspective you could observe significant share linked to the buildings. According to the Intergovernmental Panel on Climate Change residential and commercial buildings stand for almost 8\% of GHG emissions.

Fig. 8 Share of different sectors in total anthropogenic GHG emissions in 2004 in terms of CO\textsubscript{2}-equivalent

\begin{figure}[h]
\centering
\includegraphics[width=0.8\textwidth]{chart.png}
\caption{Share of different sectors in total anthropogenic GHG emissions in 2004 in terms of CO\textsubscript{2}-equivalent}
\end{figure}

Source: Climate Change 2007: Synthesis Report, Intergovernmental Panel on Climate Change

You could observe similar situation when analyzing data presented by IEA in the report \textit{CO\textsubscript{2} Emissions from fuel combustion} where residential sector contributes 6\% of CO\textsubscript{2}.


Summary

When analyzing different institutions’ trends and projections in energy, population, urbanization and GHG emissions, without a surprise, you could observe a wide supported call for action. However it is not clear on which sector should we focus on and whether it is capital efficient. To approach this question McKinsey & Company has carried out a study that aimed at mapping opportunities across regions and sectors that could significantly reduce GHG emissions by 2030 and providing cost comparisons of different solutions. They have introduced the Greenhouse Gas abatement cost curve, which illustrates their key findings.

Fig. 9 Global GHG abatement cost

The cost curve presents different solutions that are available to reduce emissions of CO₂ equivalent taking into account technologies accessible today or technologies potentially available within 2030 horizon. The width of each bar signifies the potential of the solution to reduce GHG emissions when
compared to the business-as-usual development. The height of each bar provides information on expected yearly cost of implementing particular solution that would result in avoiding 1 tone of CO$_2$ eq. by 2030. The costs are presented in 2005 real Euros and are weighted by region, sub-opportunity and averaged across the years. They were calculated on a societal perspective basis, not taking into account taxes or subsidies and assuming cost of capital for governmental bond rates.$^{13}$

This curve provides interesting comparison of different opportunities and shows four major areas of potential abatement: energy efficiency, low-carbon energy supply, terrestrial carbon (forestry and agriculture) and behavioral change.

Energy efficiency, which provides biggest abatement potential, incorporates opportunities from different sectors (vehicles, buildings, and industrial equipment). When analyzing these sectors separately regarding the emissions and abatement potential you could observe that buildings sector

provides huge opportunities. Alone it is estimated to provide 3.5 GTCO₂ per year until 2030 through direct and indirect reductions (Fig. 10).

Fig. 11 Emissions and abatement potential by sector and region

Energy usage in the building sector, both residential and commercial, is spread over different end usage ranging from heating ventilation and air conditioning (HVAC) to water heating, lightning and appliances. According to the McKinsey & Co it is responsible for 18% of global GHG emissions and is going to increase with the rate of 1.7% annually in the forecasted period until 2030. Residential buildings are said to account for 62% of emissions with commercial constituting residual 38%. Having recognized the scale of the opportunity the McKinsey’s analysts have build similar as above described GHG abatement cost curve for the building sector.
When analyzing the abatement curve for the building sector you could distinguish six major categories of opportunities:

- **New building-efficiency packages** - These solutions are focused on reducing the energy demand by advancements in the area of design and orientation. This could be achieved through using higher quality materials for insulation, walls construction as well as high-efficiency water-heating technology. Introducing these solutions minimizes energy consumption with relation to ventilation and heating while supporting high norms on air quality. Estimated of 920 MtCO$_2$e per year in 2030 results from 70% reduction in HVAC and water heating energy consumption in developed countries.

- **Retrofit building envelope** – Retrofit measures aim at reducing heating and cooling demand and are mainly concentrated on residential buildings. Depending on the scale of changes you could distinguish measures that provide reduction from 70 kWh/m$^2$ to 54 kWh/m$^2$ and consist in...
improving air-tightness through insulation of attic and adjusting air seal around areas of leakage. Further measures that could reduce HVAC consumption to around 25 kWh/m² are performed in combination with serious renovation works and include windows retrofitting, high-efficiency glazing and heat recovery in ventilation systems.

- **HVAC for existing buildings** – HVAC installations provide opportunities in residential, commercial and public buildings up to 290 MtCO₂e per year. The main solutions include replacing existing gas and oil heaters as well as air-conditioning units for more efficient that results in savings of around 20%. Additionally high-efficiency electric heat pumps could further increase savings to 35-50% depending on the climate. Finally maintenance and proper control systems could yield additional savings particularly in commercial and public buildings.

- **Water heating for existing buildings** – When considering residential, commercial and public buildings introducing high-efficiency systems is estimated to provide around 350 MtCO₂e per year reductions. These estimations assume installation of tankless or condensing heaters or solar water heaters that could achieve savings of 30% and 80% respectively while installation of heat pumps results in 65% to 80% savings. Implementation of above-mentioned solutions, particularly solar water heaters, is currently limited to developed countries and thus limit the potential of reductions.

- **Lighting** – Switching to light-emitting diode (LED) bulbs in residential buildings and improved fluorescent tube bulbs in commercial and public buildings could result in reductions up to 670 MtCO₂e per year. According to McKinsey analysts you will observe complete conversion to LEDs by 2030.
• **Appliances and electronics** – Reductions in the appliance and electronics area could amount to 550 MtCO₂e per year with 35% savings on average in the residential sector and 15% to 20% in the commercial owing to energy efficient electronics (ex. reduction of standby losses)¹⁴

Having identified different opportunities in the building sector from the perspective of the emissions abatement I would like to analyze what is the perception of potential users/customers about such solutions.

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**Customer perspective**

Having proposed different solutions for energy efficiency and carbon footprint reduction in the building sector you should analyze whether there is an interest and willingness to accommodate these proposals on the demand side. In this part I will try to determine factors that are affecting residential and commercial actors when making decisions related to the building sustainability.

**Residential buildings**

When considering forces that are influencing customers that make decision regarding sustainable products you have to be very careful with making assumptions. In order to better explain the problem I will use the hybrid cars example. Intuitively some may think that buying hybrid car is a way to save money. The performance and fuel consumption were argued to be the decisive factor when making purchase decisions. However after conducting customer interviews and going through calculations on fuel consumption savings vs premium for hybrid you could easily come to a conclusion that there must be something else behind success of Toyota Prius. In a study *Why People Really Buy Hybrids* performed by General Partner The Topline Strategy Group, you could find that interviewed customers provided interesting range of responses. Majority was led by a conventional wisdom of saving money through fuel cost savings or claiming that Prius is a cheaper alternative. For around 16% of respondents the opportunity to drive alone in a carpool lane was an important aspect while only 5% suggested that sustainable label was a decisive factor. It is interesting that customers buy a sustainable product (such as hybrid car) and claim that they are saving money even though it is not supported by reliable calculation and only minority (5%) consciously admit to buy it owing to sustainability aspect.\(^{15}\) The takeaway from

this analysis for the sustainable real estate solutions is that customer decision process could be far more complex and varied, and should not be limited to financial profit/loss calculation.

Willingness to pay for energy-saving measures and sustainability in residential buildings

In order to better understand forces shaping decision process with regard to introducing sustainability in residential building you could refer to conducted research in this field. In the paper *Willingness to Pay for Energy-Saving Measures in Residential Buildings*, authors have carried out interesting experiment on 163 apartment tenants and 142 house owners in Switzerland. The respondents were faced with a choice of housing opportunities where each set was differentiated by energy efficiency attributes and price while other characteristics were kept constant. The attributes included windows and facade with different levels of energy efficiency or presence of a ventilation system, whereas price was defined through purchase price and monthly rent expense. The results revealed variations in willingness to pay (WTP) for efficiency solutions depending on the age of the building and efficiency area (windows, facade or ventilations system). For example WTP for improvements in windows insulation is higher for older buildings, which could be explained by relatively higher utility increase when compared to new buildings where standards are already advanced whereas you could observe higher WTP for improved ventilation systems in new buildings, which could results from higher comfort expectations of the respective residents. However at the same time authors provided interesting general results showing that willingness to pay for improved efficiency is higher than the related capital expense. This outcome may suggest that there is an unsatisfied demand for energy efficiency improvement in residential buildings or that there are some barriers, which prohibit residents and owners to invest in energy efficiency
solutions. The authors point out to potential legal, structural barriers and lack of information on benefits from energy efficient solutions in economic terms.\textsuperscript{16}

Other interesting study, \textit{Willingness to pay for sustainable housing}, analyses whether people who regard themselves as environmentally friendly are willing to pay for sustainable solutions implemented in their house. The study was conducted on the transaction data of 968 single-family houses in Stockholm in 2000. The main attributes underlying empirical analysis were house price, house environmental and non-environmental characteristics (such as size, age and extra insulation, reduced water WC usage) and household characteristics including income, education and environmental awareness. The latter was based on responses to four questions asking for self-reported environmental awareness as well as specific actions in this field. Based on the collected data researchers build the hedonic price function and utility function using regression analysis. The price function equation revealed that around 70\% of variability in the house prices could be explained by non-environmental housing attributes and neighborhood characteristic. Seven out of eleven proposed environmental attributes were significant, namely: insulation, water reduction, central heating, solar energy, waterborne distribution, three-glass window and insulation wall. You could infer from the presented in the study regression results that the waterborne heating distribution and three-glass window have a highest relative influence on the price, while all other attributes reflect significant positive willingness to pay. At the same time analysis of the utility function provides interesting observations regarding environmental expenditure ratios depending on household characteristics. The correlation ratios suggest that families with higher education are less inclined to pay for environmental house features while size of the family has a positive correlation with environmental expenditure ratio. When investigating environmental awareness you could see that it has a significant impact on the utility function. This effect can be particularly observed through higher expenditure ratios for water reduction, solar energy and heating solutions in the case of

environmentally aware households. Additionally researchers investigated the causality and proved that environmental awareness is influencing willingness to pay, not the other way round. The above-mentioned results provide interesting takeaway when analyzing factors affecting demand for sustainable housing. It suggests that willingness to pay for green solutions when buying a house is not limited to environmentally aware customers but this group is significantly more likely to pay more for environmental attributes. From the policymakers perspective it supports the efforts and actions that aim at increasing the awareness while it does not preclude introducing higher cost of environmentally unfriendly solutions as this could induce higher willingness to pay among environmentally non-aware households.\footnote{17}

**Commercial buildings**

Recently you could observe increasing number of articles and press releases informing that particular company or public institution plans to move into sustainable building. Goldman Sachs confirmed that its headquarters is going to achieve LEED Gold rating while JP Morgan has achieved the highest possible rating, LEED Platinum. Some argue that these institutions aim at improving its image and simply want to benefit from positive impact of green label when attached to their brand rather than look for energy cost efficiencies. When it comes to commercial and public buildings you may quickly notice that level of sustainability is rated. I believe that particularly in the commercial sector it is crucial to be able to compare different properties basing on the sustainability level. Although it may sound easy, in practice it turns out to be more complicated.

\footnote{17} Mandell S., Wilhelmsson M., *Willingness to pay for sustainable housing*; Journal of Housing Research, Volume 20, Number 1/2011
Sustainability assessment tools

As discussed in the first section, the buildings sector contributes significantly to the GHG emissions and not surprisingly with growing pressure on differentiating buildings with various levels of sustainability, developing assessment ratings and tools has become crucial. However the task of developing rating that could be applied globally is not an easy one. Most of the real estate properties could be valued and compared by using different financial methods, including discounted cash flows, without significant considerations of the location and climate. In the case of sustainability ratings, climate and characteristic weather conditions could have a huge influence and consequently different parameters and factors should be taken into account. As a consequence there is not one globally accepted standard but rather a few internationally recognized assessment tools for certain regions. Below figure shows main international assessment tools.

Fig. 13 International assessment tools

Source: International Comparison of Sustainable Rating Tools
In order to better understand the complexity of the rating tools it could be useful to introduce and compare three main players: Building Research Establishment Environmental Assessment Method (BREEAM), Leadership in Energy and Environmental Design (LEED) and Green Star.  

BREEAM

Although Building Research Establishment Environmental Assessment Method, established in 1990 and operated by BRE (Building Research Establishment), was initially intended to serve UK non-domestic real estate market, nowadays it is regarded as the world’s first widely-used rating system for new buildings. The assessment method takes into account several categories and criteria including energy and water use, materials, transport, pollution, waste management, ecology and the internal environment. In each of the categories BREEAM assign credit points up to a total of 102 available. Final score is calculated based on weighted result in each category.  

LEED

Leadership in Energy and Environmental Design was established in 1998 in US and is operated by the U.S. Green Building Council (USGBC) – a non-governmental organization. Since its inception the rating expanded rapidly in US and at least 24 countries around the world. The construction of LEED is based on a set of credits and prerequisites that encompass: energy and atmosphere, water efficiency, sustainable sites, materials and resources, indoor environmental quality, and innovation & design process. For each

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19 BREEAM official website, Web. 14 Apr 2012  
requirement concerning these aspects (except energy) one credit point will be granted with up to 69 points that can be achieved.\textsuperscript{21,22}

Green Star

Green Star is a voluntary environmental rating system established in 2003 by the Green Building Council of Australia. It targets buildings in hot climates where solar shading and cooling systems have significant influence on sustainability. Green Star has been introduced in a number of countries including New Zealand and South Africa. Assessment methodology takes into account nine categories: indoor environment quality, energy, transport, water management, materials, land use & ecology, emissions, and innovation. Rating is based on credit points (up to 142), where final rating is determined on the percentage of the credits achieved versus available in each category.\textsuperscript{23}

Below table summarizes three main sustainability assessment ratings. When analyzing criteria weighting across different rating standards you could observe significant variations. For example LEED has a significantly higher weighting on materials while BREEAM on land use score and Green Star on water score. These differences may be explained by climate and local sustainability issues. Not surprisingly Australian Green Star puts pressure on water usage while land use is more important in densely populated UK. These variations result in difficulty to compare achieved ratings and thus for example a hypothetical building with a Six-star Green Star building (top Green Star rating) is less sustainable than a platinum LEED building (top LEED rating) and approximately equal to a Very good BREEAM rating.

\textsuperscript{21} Ibid
\textsuperscript{22} U.S. Green Building Council official website, Web. 14 Apr 2012
\textsuperscript{23} Green Building Council Australia official website, Web. 14 Apr 2012
Fig. 14 Three main sustainability assessment ratings

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<th>breeam</th>
<th>ELEED</th>
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<td>1998</td>
<td>2003</td>
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<tr>
<td><strong>Ratings</strong></td>
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<td>Certified; Silver; Gold; Platinum</td>
<td>One Star; Two Star; Three Star; Four Star; Five Star; Six Star</td>
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<td>Design/management team or Accredited Professional</td>
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<td><strong>Criteria weightings</strong></td>
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Does it pay-off

After taking into account that the sustainability of building could be measured by different standards it is of outmost importance to find if the potential investment in sustainability pays off in corporate real estate segment. In a study carried out by researchers from School of Real Estate and Planning, University of Reading, have analyzed 1,900 eco-certified buildings (626 were LEED and 1,282 were Energy Star certified) and at least 19,000 non eco-certified buildings in the corresponding metropolitan areas and submarkets. They posed a hypothesis that eco-certified buildings should generate higher rents and asset premium. Based on the hedonic regression analysis they showed that there is approximately 5% and 4% rent premium for LEED and Energy Star certification respectively. Additionally they proved that sales
premium amounts to 25% and 26% respectively and is dependent on the level of rating. Although these conclusions could be questioned due to heterogeneity issues or time specific sample bias still the study provides another proof of profits generated by sustainability in corporate real estate sector.\textsuperscript{24}

Another study carried out by Norm Miller, PhD V.P. Analytics, Costar Group aimed at checking whether optimistic results are sustainable. In his paper \textit{Does Green Still Pay Off?} he updated the data gathered before 2008 and showed that both sales and rent premium could be sustained. However positive difference may not be sufficient to explain additional investment in green technology solutions. In the next section I will try to determine what are the main factors affecting demand for sustainable real estate projects.\textsuperscript{25}

**Main factors affecting the demand**

When analyzing main factors for the development of sustainable solutions in the real estate projects it is important to recognize that you have to cope with multidimensional environment of sometimes closely related forces. Proposed list of the factors is not exhaustive but aims to provide most significant areas that should be analyzed when considering investment in sustainable real estate.

**Marketplace perspective**

From the marketplace perspective you could distinguish two parallel forces. On the one hand side energy prices are highly influencing financial aspect of the green investment while on the other side social perspective and intangible aspects play increasing role.

\textsuperscript{24} Fuerst F., McAllister P., \textit{Green Noise or Green Value? Measuring the Effects of Environmental Certification on Office Property Values}, Real Estate Economics, Volume 39, Issue 1, Spring 2011 pages 45–69,
\textsuperscript{25} Miller N., \textit{Does Green Still Pay Off?}, The Journal of Sustainable Real Estate, Web. 25 Apr 2012
Energy price and other resources
Tenant demand for sustainable real estate both on residential and commercial part of the market is highly dependent on the economic benefits related to decrease in utility charges. As mentioned in the previous sections, willingness to pay for green solutions is supported by the expectation of the energy efficiency. It is proved that green buildings are cost effective based for example on broad studies carried out by Sustainable Building Task Force\textsuperscript{26} but definitely only under certain energy market conditions and prices. As mentioned in the first section, buildings sector constitutes significant part of the energy demand and any shift in this market could have a huge consequence also for green buildings. For example in the last decade the situation of natural gas in North America has evolved dramatically with growing exploration and development of shale gas. In the early 2000’s you could have observed significant growth of LNG import terminals with 47 terminals in the permitting phase, two terminals recommissioned and expanded, and nine others constructed. The import capacity has grown from just over 2 billion cubic feet a day to over 17.4 billion cubic feet a day. The fact that most of this capacity is currently idle shows how unexpected and substantial impact shale gas has on the natural gas market in North America.\textsuperscript{27} Additionally according to EIA the importance of shale gas in the natural gas supply will increase, accounting for 46% in 2035.\textsuperscript{28}

\textsuperscript{27} Medlock K., \textit{Impact of Shale Gas Development on Global Gas Markets}, Natural gas & electricity, April 2011
Additionally you should take into account importance of natural gas as energy source for buildings sector. Currently natural gas supports approximately 40% of total energy consumption in residential and commercial buildings sector and when including natural gas used for electricity generation purposes it accounts for more than 55%.\textsuperscript{29} When you combine this information with expectations regarding decreasing natural gas prices (Fig. 16) due to shale gas extraction, cost efficiency of green solutions in real estate sector may be significantly undermined. Not surprisingly natural gas is proposed as a lowest cost strategy of CO\textsubscript{2} reduction particularly in the electricity power sector and is referred to as a bridge to a secure and low carbon future.\textsuperscript{30} Looking from this perspective one may argue that the emergence of natural gas may significantly delay introduction of green solutions or simply allow more time to develop more cost efficient zero carbon energy technology.

\textsuperscript{29} MIT Energy Initiative, The Future of Natural Gas – An Interdisciplinary MIT Study, Web. 23 Nov 2011
\textsuperscript{30} MIT Energy Initiative, op. cit.
Above presented example of natural gas influence on the cost efficiency in the US real estate sector is not isolated. McKinsey, when preparing the abatement cost curve, presented in previous section, also considered influence of volatility in energy price. It showed how changing price of oil could affect cost efficiency of solutions that aim at reducing GHG emissions (Fig. 17).
Although other sources of energy may be prevalent in different parts of the world energy price is one of the main factors affecting potential economic benefits and thus should be seriously analyzed when considering investment in green buildings.

Social perspective

Apart from economic performance the green real estate is appealing for both residential and commercial sector also owing to more intangible aspects. In the residential sector potential customers have willingness to pay for green solutions partly expecting cost efficiencies but also to show that they are environmentally conscious and want to act in a sustainable way. Potentially you could observe Toyota Prius effect discussed in the previous section where expected cost savings are not supported by viable calculations but rather an excuse for buying product with green label. However in the case of green buildings situation is a bit more complicated. Firstly the investment involved in sustainable real estate could be significantly higher as compared to car industry. Additionally used technology solutions might not be easily accessible. For example Geothermal Heat Pump technology (also known as Ground Source Heat Pumps, or GSHP) is a case of broadly recognized technology where one of the crucial barriers for implementation is insufficient experience and lack of competent designers and installers. Knowing that wrongly installed GSHP system could lead to ground water contamination potential customers are looking for more credible solutions.\textsuperscript{31} Finally when considering the growing social interest in sustainable way of life the importance of capacity to demonstrate greenness is very important. In the case of buildings demonstration effect could be achieved through similar certification process, which is already developed for commercial buildings. In 2005 U.S. Green Buildings Council (USGBC) launched the pilot test of LEED for homes. In 2008 they established certification process and there are currently more

than 15,000 certified homes\textsuperscript{32} showing success of this project in the residential market. LEED for homes certification provides not only economic benefits in terms of lower utility bills but also recognition and credibility of green investment in home property.\textsuperscript{33} Outside United States, the certification options for residential customers are limited - BREEAM is not providing certification for domestic buildings while other rating providers may not seem very credible. Although LEED is currently running an international pilot program for homeowners it may be difficult to find recognizable and comparable source for certification in residential sector. To conclude, an investment in green solutions is often supported by expectation of sustainable approach recognition and thus capacity to build demonstration effect has to be accessed in this part of the market.

In commercial part of the market situation is not that much different. Apart from financial benefits that might lure firms to green buildings there are also apparent less tangible aspects. Companies expect that green buildings could potentially improve employees' productivity, work attendance and health/well-being condition. But most importantly sustainable approach as a business value and practice has recently become target of many companies. Some believe that sustainability will improve their image among clients and customers, and so may even provide differentiating factor from competitors. Other entities have to report on their social achievements and environment play a crucial role in this respect. Finally capacity to attract workers is an important factor. Growing number of workers, particularly young and well-educated, when considering different employment opportunities, is seriously taking into account social record of a company. So one should not be surprised to see on the LEED project list major investment banks, consulting and high-tech companies.\textsuperscript{34,35}

Another group, increasingly interested in the green buildings, are investors who are concerned not only with return but also with impact of their investments. Socially Responsible Investing (SRI) is growing

\textsuperscript{32} USGBC official website, Web. 18 Apr 2012
\textsuperscript{33} USGBC official website, LEED\textsuperscript{®} for Homes\textsuperscript{™} FAQ for Homeowners, Web. 18 Apr 2012
\textsuperscript{34} USGBC official website, Web. 18 Apr 2012
\textsuperscript{35} DB Research, Green Buildings, April 2010, Web. 17 Mar 2012
rapidly both in US and Europe. According to Social Investment Forum Report the funds under management in US associated with SRI amounted to $3.07 trillion and account for over 12% of total AUM in US. Since 2005 the growth of SRI assets surpassed 34% while for broader universe of AUM an increase of only 3% was reported.\textsuperscript{36} Similar situation could be observed in Europe where SRI has almost doubled reaching €5 trillion at the end of 2009. SRI focused on a real estate is refereed as Responsible Property Investing and represented around 3% of total European SRI AUM.\textsuperscript{37} There are many works suggesting that optimal allocation to the real estate should be in a range between 10-20% in a portfolio so definitely you could observe an underweighting of green real estate in SRI. One of the main reasons for this negative situation is lack of comparable metrics that would support investors in commitment to RPI. Ratings like LEED or BREEAM are useful when comparing individual buildings however in case of big portfolios where the number of properties hold by the investment fund may be dozens or even hundreds the metrics should encompass broader scope of issues.\textsuperscript{38} One of the projects that aims to address this problem is the Global Real Estate Sustainability Benchmark which is based on surveys that encompass 50 data points regarding environmental and social performance of real estate company or fund. Final score is weighted by seven subcategories and results in 39 metrics. In the 2011 Research report, the Foundation consolidated data from 340 respondents whose aggregate value of real estate managed has almost reached US$ 1 trillion threshold. The results showed that there is not only an increasing number of private property funds responding to the survey but also a significant progress in terms of environmental performance. Although the investment industry is mainly profit rather than value driven, authors of the report suggest that expectation of socially responsible investment combined

\textsuperscript{37} European Sustainable Investment Forum, \textit{European SRI Study}, 2010
\textsuperscript{38} Pivo G., \textit{Is There a Future for Socially Responsible Property Investments?}, Fall 2005, Vol 30, The Counselors of Real Estate

33
with government intervention in regulations incentivize fund managers to take green path in real estate sector.\textsuperscript{39}

\textbf{Regulation}

Regulation plays crucial role when considering green buildings sector development. As general public is becoming more interested in the subject of GHG and CO\textsubscript{2} emissions reduction, politicians are also more likely to address this problem. Current market mechanism seems insufficient to accomplish targets with respect to CO\textsubscript{2} emissions that would yield noticeable progress. Externalities of GHG are more recognized on a society level rather than on private level. Not surprisingly climate change is currently a major policy concern. As discussed in the first section, buildings sectors contribute significantly to the GHG and at the same time it provides huge reduction potential combined with positive profit-loss calculation. Mentioned before negative abatement cost calculated by McKinsey, suggests that politicians should introduce regulations that would support change to sustainable buildings which would provide sufficient cost efficiencies to advocate investment. When considering different policy changes and regulations it is useful to understand the barriers and process related to the green buildings investment.

\textbf{Fig. 17 Life cycle of buildings}

\begin{center}
\includegraphics[width=\textwidth]{life_cycle_of_buildings.png}
\end{center}

\begin{flushright}
\textbf{Source: Institute for Building Efficiency}
\end{flushright}

\textsuperscript{39} Global Real Estate Sustainability Benchmark, \textit{Research report 2011}, Web. 27 Dec 2011
In the Design and Construction phase it is critical to address architects, engineers and developers to support green solution. The first barrier that should be overcome is potential lack of awareness of the main actors about the opportunity and technical capability to access the cost benefits of energy efficiency. Policies that aim to build awareness and technical capacity in the market could include awards and competitions that provide recognition of energy efficiency and sustainability improvement. Promotion of already established rating and certification programs combined with the mandatory disclosure requirements regarding building performance would potentially improve market transparency and capacity to compare projects. Finally training programs that would educate architects, engineers and developers on successful implementation of sustainable buildings and reliable cost benefits estimation. In the Design and Construction phase there are also market and financial barriers. Developers and architects may be reluctant to introduce sustainable solutions as this would result in increased sale price while potential benefits to occupants are difficult to present. In this case building energy codes and standards that would provide comparable source of performance is essential. These regulations should be customized depending on the climate zone and local conditions. In the Sale, Leasing and Operation phase barriers result in misevaluation of energy efficient aspects and sustainable components. The owners, tenants and real estate agents do not have sufficient information concerning building performance and potential future savings or do not posses technical knowledge to include this aspect in the valuation. This lack of awareness and technical capabilities is similar to issues arising in the Design and Construction phase and thus suggested policy measures also include increased disclosure requirements and education projects. Additionally barriers face in the Sale, Leasing and Operation phase could be addressed by utilities through advanced metering infrastructure, dynamic pricing of electricity or utility public benefits fund. Also local government could significantly reduce current limitations by introducing tax incentives, grants and rebates or revolving loan funds. Similar actions could have high
influence on potential retrofit decisions. In this case awareness, technical capacity as well as financing aspects should be considered.\textsuperscript{40}

\textsuperscript{40} Institute for Building Efficiency, \textit{Driving Transformation To Energy Efficient Buildings}, December 2011
Conclusion

Having analyzed relationship between energy market, changing demographics, urbanization patterns, GHG emissions and some available technologies that provide energy efficient solution one may easily claim that green buildings are not a far future but rather an imminent solution. On one hand side you could observe increasing urbanization and population growth particularly in developing countries that is combined with growing energy consumption. At the same time increasing scarcity of energy resources and volatility of prices makes available more and more technologies that provide energy efficient solutions. Finally there is an increasing social anxiety about climate change triggered by GHG emissions. From this point of view a green real estate is a sure bet. However when you translate this global perspective and obvious solution into actionable measures on residential and commercial market you start to realize that other additional factors should be taken into consideration. First social aspect has a major significance in this case. In the residential sector it could be identified as demonstration effect where potential customers, although motivated by economic benefits, are looking for solution that would provide recognizable confirmation of their sustainable approach. Willingness to pay for sustainability may be to some extent unconsciously dependent on capacity to display it. Similarly in the commercial market, companies are increasingly paying attention to sustainability issue from public relations and image perspective. In this area capacity to quantify and rate sustainability is very important. There are already developed and increasingly widely applied rating tools like BREEAM or LEED however there is no one global comparable tool. Although you could observe significant improvement in this area, also on the residential side of the market, still sustainability is difficult to compare and quantify among projects, particularly in locations with different climate characteristic. In above-mentioned limiting factors one should additionally include lack of technological capacity and experience to implement some of available technological solutions and limited awareness about available opportunities. As discussed in the previous section these problems could be addressed with
different policies depending on the life stage of the building. Regulators have a wide variety of tools and measures to promote and help implement sustainable solutions in real estate market and you could observe increasing number of actions mentioned being implemented.

Finally when assessing investment opportunity in the green technology real estate one should analyze the timing of the investment. Firstly the construction cycle plays huge role. On one hand side you could observe influence of macroeconomic factors such as GDP growth, unemployment or interest rate, which could determine access to capital and growth in the real estate industry. On the other side the construction cycle is significantly affected by demographic and urbanization changes in micro and macro scale. Secondly when deciding to introduce a green solution to real estate it is crucial to investigate cycle of the underlying technology. Although some of the available technologies are already well developed and potentially relatively easily could be implemented in the real estate area one should consider solutions that are less recognized but could provide an advantage for a longer period of time. Above-mentioned construction cycle might be longer than the cycle of the used technology what could result in diminishing or shorter than expected premiums for the green attribute of the property. Particularly in the context of new construction rather than retrofit this aspect ought to be taken into account. Additionally decision regarding used technology may be analyzed from the perspective of balance between realized cost efficiency, expected green attributes and cost of introducing certain solution. Assuming that a more advanced, novel and less developed technology could provide diminishing cost efficiencies on a dollar investment basis compared to already established solution which in a later stage of cycle, investor has to figure customers willingness to pay for green technology relative to expected greenness duration. Finally environmental policy and regulation may significantly influence timing of the successful green buildings investments. Environmental policies and potential support for green solutions could be analyzed on the elections cycle basis where different political fractions, depending on the budget deficit, give priority or delay green developments. But the underlying factor is the sentiment in
the society, which is partly shaped and affected by unexpected or unusual events. In the case of environmental policies and green technologies any unusual climate phenomenon, increased number of climate anomalies or tragic consequences of natural disaster such as Fukushima earthquake may trigger social interest and potentially result in regulations that may favor green solutions. Investor has to be aware of above-mentioned cycles to accurately time the investment.

From global perspective implementation of green technologies in real estate seems a huge opportunity. However when making decision on particular project, investor has to take into account many factors ranging from location specific energy market situation, through social aspects, to regulatory environment. I believe this is a very difficult task but hopefully more and more investors will take this risk resulting not only in profitable but also sustainable investments.
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