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Sustainability and Property Valuation – A Risk-Based Approach

Erika Meins[*], Holger Wallbaum[○], Regina Hardziewski[♦], Annika Feige[•]

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Executive Summary

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Keywords

Sustainability, property valuation, discounted cash flow, risk model, sustainability features, economic sustainability indicator, sustainable buildings

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Sustainability and Property Valuation – A Risk-Based Approach

1 Introduction

Energy efficient properties achieve a premium price in some markets. Based on a broad data basis, a recent study shows that the property market in Switzerland has – on average – paid a premium of seven percent on the purchase price for energy-efficient single family houses and a premium of 3.5 percent for freehold apartments during the last ten years (Salvi et al., 2008). These results have been confirmed by similar studies in the USA (Miller et al., 2007, Eichholtz et al., 2009). Empirical evidence also suggests that office buildings with a „green rating" generate rental income which is three percent higher per square meter compared to non „green" buildings (Eichholtz et al., 2009). An analysis of a portfolio consisting of Energy Star[1] labelled office properties shows that these properties had "5.9% higher net incomes per square foot (due to 9.8% lower utility expenditures, 4.8% higher rents, and 0.9% higher occupancy rates), 13.5% higher market values per square foot, 0.5% lower cap rates, and appreciation and total returns similar to other office properties" (Pivo and Fisher 2009). The results of a study about the effect of eco-certification on the rental and sales prices of US offices properties confirms that there exists a rental premium of about 6% for LEED[2] and Energy Star certification (Fuerst and McAllister, 2009).

However, energy efficiency is only one aspect of a sustainable property, and rising energy prices are only one example of long-term changes that are anticipated today. Other changes include global warming, demographic changes and changing social standards are aspects that should be covered by a holistic sustainability assessment. Some of these developments can also have an impact on the value of real estate. Property owners are becoming increasingly aware of this and sustainability features seem to matter increasingly to property owners (RICS, 2009). These value-related aspects are the focus of the authors of this paper. According to a recently published survey, 59 percent of the approximately 100 property investors interviewed stated their intent to invest much larger amounts in sustainable property (Union Investment, 2008). More than half of the investors who were interviewed in Germany believe that higher prices can be realised with sustainable property than with conventional property (Union Investment, 2008).

It is assumed that many investors, principals, building owners and planners believe that a sustainable building is primarily characterized by its environmental related parameters or – even more limited – to its energy demand for electricity, heating and cooling. This understanding is still widespread, also visible in the criteria of the internationally renowned building labelling schemes LEED and BREEAM, but obviously too short-sighted. Lützendorf and Lorenz (2005) provide a more elaborated classification of buildings that contribute to a sustainable development. Based on a classification of areas of protection "protection of the natural environment, protection of basic natural resources, protection of human health and well-being, protection of social values and public goods, protection and preservation of capital and material goods" (Lützkendorf and Lorenz, 2005) the authors derived a more comprehensive set of requirements to classify sustainable buildings.

This more holistic interpretation of a sustainable building that is also shared by the authors of this article has also been the basis for a new Labelling scheme, developed by the German Association for Sustainable Buildings (Deutsche Gesellschaft für Nachhaltiges Bauen, DGNB)[3]. The approach represents the second generation of labelling schemes for buildings, covering the three dimensions of a sustainable development following the Brundtland definition (WCED, 1987), whereas the majority of building labels are still these of the first generation (environmental and energy focused).

Apart from rising energy prices, this is another reason for a high level of dynamism in the construction of (only) energy-efficient buildings that can be observed, particularly regarding new buildings. In Switzerland, for example, the stock of energy-efficient Minergie®[4]

buildings, which are commonly viewed as being „sustainable“, has tripled between 2004 and 2008. This dynamism is also evident in LEED certification – for example in commercial construction registered to receive LEED certification: From 3% in 2002 (USGBC, 2002) the annual volume has risen to 6% in 2008 – according to some estimates (Hoffman and Henn, 2008). Despite all of this, the proportion of actually built sustainable properties remains low. In the USA there are currently only 1,703 LEED certified buildings (Eichholtz et al., 2009) – an insignificant amount compared to the 1.8 million houses and 170,000 commercial buildings that are built each year (Hoffman and Henn, 2008). With 12,579 buildings in Switzerland, the proportion of Minergie® buildings represents only about one percent of the total stock (Steinemann et al., 2008).

There are various reasons for the low proportion of energy efficient and sustainable property. One of them is that property is a fairly durable asset. In Switzerland, the annual proportion of new buildings represents less than 1% of the total stock. Even with a high level of conversion, it will take some time for an appreciable share of the stock to be renovated.

A further reason for the slow implementation of veritably sustainable properties is that there is a lack of a true understanding of what sustainable property really is. Relatively clear concepts exist only with regard to technical aspects such as energy efficiency and building ecology, while the social aspects and economic issues remain largely unclear. In this regard the DGNB label provides a significant step further in the concretization of the non-environmental dimensions within a sustainable building scheme.

In addition, the slow rate of implementation of sustainable property can be traced back to the fact that sustainability is only taken into account to an insufficient extent if at all when appraising a property financially (Schäfer et al., 2008, Sayce et al., 2006, Lorenz and Lützkendorf, 2008). The Royal Institution of Charted Surveyors (RICS) has acknowledged this recently (Lorenz et al., 2008) and has drafted a Valuation Information Paper (VIP) as a first step to bridge this gap (RICS, 2009). The VIP clarifies that valuers' role is solely to reflect the market's assessment of an asset's future performance and that if the market does not differentiate between sustainable and non-sustainable properties, there will be no impact on value. However, as is stated in the RICS VIP "within the UK, the US and other mature and transparent markets, there are signs that, increasingly, sustainability criteria matter to property owners (be they owner-occupiers or investors) and to tenants" (RICS, 2009). Since valuers attempt to base their valuations on empirical evidence they are forced to rely on market data, which is per definition historical data since the market is in constant evolution (Szerdahelyi, 2006). It is therefore in the nature of valuations that new market trends, e.g. investors paying a premium for sustainable properties, are reflected with a certain time lag. The solution to reduce this "valuation lag" is to provide valuers with quantitative information on the effects of long-term developments on property values to enable the integration of value-related sustainability features into property valuation.

This article pursues two goals. First, for the purpose of property valuation, sustainability is defined from a financial point of view and substantiated so that it can be measured with concrete features and indicators. And second, the ESI® Property Valuation is presented – a risk-based attempt to show how existing valuation methods can be supplemented by those sustainability aspects, which have an effect on the financial value of a property. The article focuses on the Discounted Cash Flow (DCF) method as it is commonly used in many parts of Europe and is the preferred method for many real estate valuators. Finally, the limits and opportunities of this attempt as well as the most important consequences from these findings for practical experience will be examined.

2 The Need for a Sustainable Property Valuation

2.1 Point of Departure Property Valuations

Real estate differs from many other assets due to certain specific features (Gantenbein, 1999). The special challenges in valuing real estate can be attributed to some of these special features. Property is an immobile asset and is characterized by a high level of longevity. Each property is singular on the one hand because of its geographic and topographic uniqueness and on the other hand as a result of the large number of variable building characteristics. In contrast to shares or securities, the price of real estate cannot be determined without a transaction taking place due to the fact that each property is unique. Instead, a property's value needs to be estimated as an approximation of the price.

There is no generally applicable definition of real estate value. In practice, the concept market value has become prevalent. The International Valuation Standards (2005) define market value as „the estimated amount for which a property should exchange on the date of valuation between a willing buyer and a willing seller in an arm's-length transaction after proper marketing wherein the parties had each acted knowledgeably, prudently, and without compulsion".

A further common definition is the value in use or worth.[7] According to RICS "worth is a specific investor's perception of the capital sum which he would be prepared to pay (or accept) for the stream of benefits which he expects to be produced by the investment"(RICS, 1997). In the framework of real estate, value should always be referred to price (value in exchange) not worth (value in use). Both price and value are in line with the market, while worth is subjective and based on the particular requirements of the client. In the property market a valuation is often defined as the best estimate of the exchange price of the building and calculation of worth is the individual assessment of worth to a specific investor (RICS, 1997).

The large number of value concepts is reflected in the large number of valuation methods and valuation standards such as the USPAP in the USA, the RICS Red Book in the UK, the Blue Book as the European standard and the White Book as the international standard. The most common property valuation methods used today can be divided into three main groups: *Sales Comparison Approaches, Income Capitalization Approaches* and *Cost Approaches*.

While RICS states that "the choice of method to be employed in making a valuation must always remain with the valuer" (2001), the choice of the valuation method is generally determined on the basis of the goal of the valuation and the purpose for which the property is used (self occupancy or as an investment). A reason for valuing a property includes the purchase or sale of a property, granting mortgages, insurance and tax issues as well as the valuation of property assets for companies and institutional investors. In many European countries, including Switzerland, the DCF method – belonging to the Income Capitalization Approaches – has become the most commonly used valuation method for investment property. In the following, therefore, only the DCF will be discussed and the other methods, as they are not relevant for this paper, will be omitted. [8]

DCF is a method of dynamic investment valuation which discounts future cash flows (revenues and expenditures) to a single reference date to obtain the present values which are added afterwards. The sum of the present values results in the net present value (White and Jenyon, 2003). RICS defines the DCF as a "technique used in investment … appraisal whereby future inflows and outflows of cash associated with a particular project are expressed in present-day terms by discounting" (RICS, 2001). In the so-called two-phase-approach, two time periods are distinguished. In the first period of the DCF-Model the cash-flows forecasted for the next 5 to 10 years are discounted. The forecasts of the cash-flows are based on known developments from lease contracts (e.g. indexed rents) and expenditures (e.g. renovation in 5 years). In the second period the residual value[9] at the end of the period under consideration is calculated by income-capitalization. The market value results from the sum of the discounted cash-flows within the period under consideration and the residual value. The discount rate plays a central role in the determination of the market value. An important task of the discount rate is the consideration of those risks, which are not otherwise considered in the DCF, i.e. by the cash-flows.

2.2 Three Challenges for Property Valuation

Because quantifying the value of real estate ultimately is based on estimates, the range of options while valuating real estate is broad. In practice there are three main challenges: how to deal with uncertainties ("Valuation Uncertainty"), the lack of transparency ("Valuation Black Box") and the tendency of valuations to lag behind market trends ("Valuation Lag").

Valuation Uncertainty. Valuations can only be as good as the data on which they are based. "All valuations are estimates and carry with them a degree of uncertainty. The range of uncertainty may vary in different market conditions and for different types of property" (RICS, 2001). The accuracy of the value determined primarily depends on which factors are included in the valuation and on which basis of data and experience these factors are quantified. Experience shows that regardless of the method applied, estimation errors of from ±20 to ±30 percent can occur (Maier, 2004, UBS, 2005) and an empirical study for Switzerland shows that one third of all valuations have estimation errors that are larger than ±10 percent (Tochtermann, 2003). The reason for the large margin of error is not primarily methodological deficiencies, but rather incomplete information, especially concerning new market trends and developments in the future.

For the DCF method, the assumptions regarding future cash flows as well as the choice of the discount rate determine the value. On the income side this concerns the rental potential minus vacancies as well as the costs for maintenance and renovation as well as the running costs on the costs side. Studies of individual value drivers show that the discount rate has a particularly high leverage effect in this process, namely up to 40 percent (Schwartz, 2006, Szerdahelyi, 2006), i.e. small changes of the discount rate lead to high variations in the estimated value. An accurate determination of the discount rate is therefore preferable to reduce the margin of error or the "Valuation Uncertainty".

Valuation Black Box. The definition and determination of the discount rate used in the DCF method are not specified in detail – neither in the real estate practice nor in the International Valuation Standards (IVS) or in the International Accounting Standards (IAS) (Frank, 2007). In practice – at least in Switzerland – , the discount rate for the DCF method is determined chiefly by using the so-called "Risk Premium Model", also known as "Risk Component Model" (Shilling, 2002). The basis of this is the return on a risk-free capital investment. Risk premiums for the general real estate risk as well as for the property specific risk are added to the return on the risk-free capital investment. The Appraisal Institute® states that "…a discount rate may be developed with the *built-up method,* which involves adding together the four components in the rate, i.e., a basic safe or riskless rate plus adjustments for risk, illiquidity, and management"[10] (Appraisal Institute, 1996). In addition to this approach, there exists more empirical approach, which is applied less frequently in practice. In this case, market data is used as a basis to determine the discount rate. Depending on the property risk, which is estimated individually, this empirically determined rate is adjusted upwards or downwards.

Not all valuation reports disclose how the discount rate was derived and whether or which of the risk components were used. The discount rate is therefore similar to a "Black Box". This is particularly problematic because the discount rate is one of the value drivers with the greatest leverage (Schwartz, 2006).

Valuation Lag. The worth of real estate depends to a large extent on the development of exogenous framework conditions. For some of the framework conditions, long-term changes can be anticipated today. These include climate change, demographic changes or rising energy prices. A weakness of current valuation methods is that in their commendable attempt to base the valuation on empirical evidence they are forced to rely on market data, which is per definition historical data since the market is in constant evolution (Szerdahelyi, 2006). It is therefore in the nature of valuations that new market trends are reflected with a certain time lag. This creates a time slot of insecurity for valuers and leads – among other things – to an initial failure to take the consequences of long-term changes into account. Since many sustainability features are related to emerging long-term developments, this leads to a failure of valuations to take worth-relevant sustainability features into account. This is especially aggravated for those DCF valuations, which are not based on new rental agreements because here the income cash flows are based on market data that may be several years old. In general, it is a contradiction that the DCF method attempts to estimate today's market value based on estimations of future cash flows. This contributes further to the inaccuracy of DCF valuations, as it is not always clear what the market's expectations for the future are. In sum, the "valuation lag" leads to valuers lagging behind the market when it comes to integrating value-related sustainability features in their assessment of a property's value.

3 ESI® Property Valuation

Because existing valuation methods are widely accepted and, in addition, the mentioned challenges are not due to the valuation methods but rather to the input data and the lack of transparency, an approach has been developed which builds on existing valuation methods (in particular DCF). By using the ESI® Property Valuation, current valuations are supplemented by the CCRS Economic Sustainability Indicator ESI® in order to integrate the consequences of long-term developments, which are not yet taken into account or only to an insufficient extent in valuations due to the before mentioned valuation lag.[11] As elaborated above, estimating the value of a property is associated with a high level of uncertainty and, moreover, the issue of sustainability and valuation is situated within the blurriness created by the valuation lag. Therefore, it is not possible to come to a final conclusion whether the estimated value resulting from an ESI® Property Valuation reflects the market value or the worth of a property.

Based on our own observations of the market and anecdotic evidence we strongly have the impression that the market in Switzerland is increasingly paying a premium for the value-relevant sustainability features described subsequently. This conclusion is also supported tentatively for markets in the UK, US and some other countries by a new RICS Valuation Information Paper (RICS, 2009). We therefore believe that the ESI® Property Valuation is increasingly reflecting the actual market value. Obviously though – and possibly due to the valuation lag – the available empirical evidence is not strong enough to support this impression. To be on the safe side we therefore propose to use the ESI® Property Valuation as a calculation of worth. In the end, however, it is up to the individual valuer to decide about whether to use the ESI® Property Valuation as a calculation of worth or an estimate of market value based on the actual market data/view of the specific country.

3.1 Sustainability of Property from a Financial Point of View

3.1.1 Definition

In order to incorporate sustainability aspects into property valuation in a systematic way, it is first necessary to define and substantiate sustainability relating to property from a financial point of view. The term sustainability is used in general and for property in particular far too frequently and usually inaccurately. The reasons for this are the complexity of the subject and the fact that there is a lack of a satisfying definition. In addition to the environment, current sustainability concepts concentrate increasingly on society and the economy, e.g. the triple bottom line approach (Elkington, 1999). Therefore, a clear differentiation of sustainability especially from "green building" definitions have to take place (Lützkendorf and Lorenz, 2007). Following the definition of sustainable development arising from the Brundtland Report (WCED, 1987) we put forward the following definition: a property is sustainable if it provides long-term environmental, social and economic benefits or at the least avoids harm in these areas.

Existing approaches to define and substantiate the sustainability of property generally concentrate on technical aspects and therefore implicitly on environmental sustainability (see amongst others Haute qualité environnementale (HQE), Leadership in Environmental & Energy Design (LEED), BRE´s Environmental Assessment Method (BREAM) etc.) (Wallbaum, 2008).

If the financial value is the main concern, as is the case for valuation, then the focus of sustainability should be on the long-term economic benefits. The social and environmental benefits are in this understanding secondary considerations, which should be satisfied if possible. From the point of view of an investor, mortgage lender or owner, a sustainable property within this approach corresponds to a property which maintains its value or increases in value in the long term. In this definition, a sustainable property provides investors with a secured long-term profit.[12]

When considered from a dynamic financial point of view, property is sustainable if it – ceteris paribus – can easily deal with changes to the environmental, social, political and economic framework conditions (adaptability) and therefore minimizes the risk of a reduction in value or increases the opportunity of an increase in value. A property, for example, which remains cool in summer because of the quality of its construction, will experience a greater increase in value the more hot days occur due to climate change. When deriving concrete sustainability features, it is therefore vital to recognize the long-term developments relevant to property and to derive the consequences for the property value from them.

3.1.2 Long-term Developments with Consequences for the Value of Property

Assuming a long-term perspective as the core component of sustainability, the question arises, which long-term developments or framework conditions will have an effect on the value of property. However, only those framework conditions, whose developments have a clear direction, can be taken into account. Without a clear direction (trend) it is not possible to forecast the effects on the value of property. Existing state-of-the-art scientific scenarios from sources like the Intergovernmental Panel for Climate Change (IPCC) or the Federal Statistic Office provide the fundament for the selection of the relevant framework conditions.[13] The scenarios on which the following forecasts are based refer to Switzerland, but are likely to also be relevant in a modified form for most industrialized countries:

- As a result of demographic change, in many industrialized countries population scenarios predict a decline in the number of people in the workforce and an increase in the proportion of older people (over 65 years old) in the population (BFS, 2005).
- Due to rising fuel prices and the increasing proportion of older people, the demand for public transport will increase (EEA, 2009, BFE, 2007).
- Due to continually rising greenhouse gas emissions, climate change will accelerate and lead amongst other things to more frequent and longer heat waves in many areas as well as more frequent extreme weather events such as storms, torrential rain and hailstones (OcCC, 2007).
- The price of fossil fuels will rise on the one hand due to increased scarcity and on the other hand because of increasing costs of CO_2 emissions. As a result of increased demand (due in part to the substitution of crude oil by electricity), the price of electricity will also rise (Prognos, 2005).
- From a global point of view the emerging water shortage will lead to water becoming more expensive (UNESCO and Earthscan, 2009).
- As a result of social trends, populations' requirement for security and general health awareness will continue to increase (GdW, 2008).

3.2 Features of the ESI® Property Valuation

The CCRS Economic Sustainability Indicator ESI® is an attempt to measure the risk of a property losing value or the opportunity of gaining value due to the future developments. This risk-based approach to sustainability is not a totally new concept, as there are a number of German banks which use "rating criteria that allow treating unsustainability as property risk factors" (Lützkendorf and Lorenz, 2007) and the view that sustainability is an additional and changing set of risks for property investors has also been put forward by other authors (Ellison et al., 2007). At the same time, the ESI®-Indicator tries to improve the transparency of the DCF method in determining the property risk used in the discount rate. Since the cash flows in the DCF method are forecasted as accurately as possible over the next 5 to 10 years and then capitalized for the remaining property life, the ESI®-Indicator assumes a differential approach, i.e. long-term aspects are incorporated by determining the difference between the consequences of current framework conditions and the consequences of the anticipated change in these conditions. The indicator is therefore specified in such a way that it only includes the risks which result from between 10 and approximately 35 years as of today. This means that only those risks are included, which are not already indicated in the cash flows of DCF valuations (see Figure 1 and chapter 2.1).

The ESI®-Indicator is integrated in the DCF method in the discount rate, namely as the property risk (also referred to as beta-factor) – if so far not specified – or as an addition to the property risk. Apart from this, the discount rate is determined the same way as is normally the case by using the risk component model. To determine the weighting of the indicator when incorporating it into DCF a risk model was specified and quantified (Holthausen et al., 2009). The specification of the risk model and the weighting results are described in chapter 3.3.3.

As an alternative to this risk-based approach, cash-flows could be modelled for the total property life taking the consequences of long-term developments into account. This approach was not adopted for two reasons. First, there is a high degree of uncertainty associated with the consequences of long-term developments. Therefore a risk-based approach, which allows for different scenarios and according probabilities and consequences, is in our opinion more adequate. The second reason is a practical one: in Switzerland the use of the two-phase DCF prevails and therefore a compatible approach (i.e. modelling cash-flows for 5-10 years and addressing sustainability issues with the risk-approach) was favoured.

3.3 Operationalising the CCRS Economic Sustainability Indicator ESI®

Five steps need to be taken to operationalise the ESI®-Indicator. To begin with, the sustainability features which are relevant to the long-term property value are derived based on the anticipated long-term developments which have already been described. The next step involves specifying and codifying measurable partial indicators for the latter. The weighting of the partial indicators is carried out based on a risk model. The coded and weighted partial indicators are subsequently combined to become the ESI®-Indicator.

3.3.1 Derivation of the Sustainability Features

The derivation of the sustainability features based on long-term developments will be presented in the following. In accordance with the economic model of the property market of DiPasquale and Wheaton (1996), four types of effects need to be differentiated: changes to the exogenous framework conditions might lead to a *change in demand depending on floor space* or *investment opportunities* in property or to a *change in the supply of new buildings* or *in floor space*. These changes can be *quantitative* and/or *qualitative* in nature. A quantitative effect results in a change of the amount of floor space or investment opportunities demanded or supplied: A decreasing number of people in the labour force for example means that the demand for office space will decline. Ceteris paribus a decreasing number of people in the labour force also mean a lower wage bill, less available resources for property investments among the labour force and of pension funds, therefore resulting in a decline in the demand for property investment.

A qualitative change leads only to a shift in demand or supply. The demand for (or the supply of) property with certain features is shifted towards property with other characteristics. If, for example, the proportion of older people in the population rises, then the relative demand for obstacle-free (and therefore wheelchair accessible) residential property increases to the disadvantage of residential property with steps, thresholds, and other obstacles which cannot be tackled without assistance if using a wheelchair.

In this context, it is primarily the qualitative changes in demand which are of interest because they indicate which property features will increase in importance in the future. The sustainability features of property, which will increase the value of the property on the basis of anticipated long-term developments, which have been described previously, have been determined step by step. A timeframe of approximately 35 years has been assumed for the long-term developments.

The derivation of the sustainability features is based on a broad national discussion with leading property experts[14] and scientists[15] over a period of two years. Simultaneously, other supporting methodologies have been used to support the educated guess that the sustainability features on which the ESI® valuation relies are actually value drivers. For instance, a hedonic analysis has been conducted to demonstrate the willingness of the market to pay more for energy-efficient buildings Switzerland (Salvi et al., 2008). Based on a broad data basis, this study shows that the property market in Switzerland has – on average – paid a premium of seven percent on the purchase price for energy-efficient single family houses and a premium of 3.5 percent for freehold apartments during the last ten years. In addition, it would be desirable to demonstrate the importance on property value for the other sustainability features as well, e.g. by conducting further hedonic analysis. So far this uncertainty has been addressed by a scenario-based risk assessment for each criterion within the list of sustainability features (a more precise description is given in chapter 3.3.3).

The property features described in Table 1 represent the actual value-related sustainability features. They are divided into five groups of property features: flexibility and polyvalence, energy and water dependency, accessibility and mobility, security as well as health and comfort. Some of the property features are new. However, others such as public transport connections are already taken into account in current valuations, but not to a sufficient extent – in view of the anticipated long-term changes to framework conditions.

Flexibility and Polyvalence. Property features that affect the flexibility and polyvalence of a property are selected on the one hand on the basis of emerging social changes (demography and structure of households) and on the other hand they are a response to future changes in framework conditions, which are not foreseeable today and for which there is therefore no clear trend. For example, it cannot yet be foreseen today which technological developments will make it necessary to lay new cables (such as for example with LAN cables in the past).

In the case of flexibility and polyvalence, a distinction is made between flexibility of use and user flexibility. With regard to flexibility of use, this means that a property permits various uses (such as residential, office, medical practice, day care facility for children etc.). As far as user flexibility is concerned, this means that a property should be able to be used by different kinds of users (such as older people, families with small children, wheelchair users etc.).

Energy and Water Dependency. With regard to energy and water dependency, it is a question of seeing how well a property can deal with the consequences of climate change as well as with rising energy and water prices. As far as energy is concerned, on the one hand it is a matter of energy efficiency, i.e. an energy consumption which is as low as possible for heating (heating and hot water) and cooling (on the basis of global warming the demand for cooling will increase in the summer). On the other hand, the dependency on energy sources or the expected energy costs of these will play a role. Decentralized renewable energy in the form of electricity and heat (solar and wind energy, ambient heat and geothermal energy etc.) reduces dependency on non-renewable energy sources[16] and in this way reduces the risk for future cost rises. With regard to water dependency, low water consumption, the disposal of wastewater as well as collecting rain water will increase in importance.

Accessibility and Mobility. On the basis of rising fuel prices and a higher proportion of older people in the population, the proportion of public and non-motorized transport will increase. The site which should be assessed can therefore be described as sustainable if on the one hand it has good connections to public transportation (short distance to bus stop or train station as well as high frequency of transport), and on the other hand, if it can be easily and safely reached by non-motorized traffic such as bicycles or pedestrians and if space for bicycle racks are provided. As far as accessibility is concerned, a short distance to the nearest local centre, shops for daily provisions and local recreation (e.g. woods, rivers, lakes) play an important role.

Safety and Security. On the basis of climate change it is expected that in future extreme weather events (floods, storms, hailstorms etc.) will increase. A sustainable property minimizes the risk of suffering damage from the expected extreme weather conditions in the future by not being located in a potentially high-risk area.

Additionally, property-related safety measures such as for example special construction measures providing precautionary protection against flooding can increase the value of a property. Safety and security measures relating to people are increasing in importance due to increasing awareness in the population. Good lighting and illumination should be considered, in particular with regard to areas without good visibility such as underground garages. Furthermore, suitable fire prevention or escape routes and emergency exits need to be considered.

Health and Comfort. Increasing security requirements and health awareness will continue to lead to an increase in the significance of property-related health and comfort aspects. A sustainable property has high air quality amongst other things. This includes a low level of ozone, fine dust and radiation exposure (electromagnetic pollution and radon emissions) as well as the use of ecological building materials, which do not emit any harmful substances inside the building. With regard to location-dependent air pollution, air conditioning with the appropriate filters represents a sustainability feature.

A low exposure to noise is another sustainability feature. Air conditioning can also be an advantage in noisy locations. Lastly sufficient daylight should also be mentioned: a building design, which ensures sufficient daylight, will become increasingly important due to rising health awareness but also because of rising costs for lighting (electricity).

3.3.2 Operationalization: Further Steps

In addition to the determination of the five groups of sustainability features, the following additional steps were carried out in order to operationalise the ESI®-Indicator.

- Partial indicators were determined for the five groups of sustainability features. The chosen partial indicators are a compromise between plausibility and practicability. While chosen to be as accurate as possible, they ensure that the necessary data is actually available in practice or is easy to collect.
- With regard to coding, the best specification was allocated the value +1 (the most sustainable) and the worst specification was given the value -1 (the least sustainable). The value 0 corresponds to an average new building (in relation to the building stock).
- Partial indicators and coding were validated as part of a board composed of experts from practice and academia during a two-year consultation process.
- A risk model was specified in order to quantify the weighting, which is described in more detail in chapter 3.3.3.

– The coded and weighted partial indicators were summarized into the CCRS Economic Sustainability Indicator ESI® (the application is demonstrated on practical examples in chapter 3.4).

The specification of the ESI®-Indicator is represented in Table 2. Obviously, different property types (e.g. residential versus offices) have different requirements of use. This has consequences for the operationalisation of the sustainability features. Therefore the ESI®-Indicator is specified separately for apartment, offices, and sales buildings. A simple standalone software is available for the application of the ESI®-Indicator.[17]

3.3.3 ESI® Risk Model

In order to quantify (or weigh) the ESI®-Indicator a risk-based weighting model was adopted. To derive the weighting in an as systematic way as possible the ESI® Risk Model was developed in collaboration with risk experts[18]. Obviously, quantifying the risk poses a big challenge as it requires estimating the probability of future developments occurring and the magnitude of their consequences on property values. A high level of subjectivity is inevitable. Moreover, in able to specify a model and estimate the input parameters, it is necessary to adopt many simplifying assumptions.

We addressed these challenges by three means. First, as a means of reducing the subjectivity, we had seven real estate experts replicate the original estimations independently (and without knowledge of the original estimations) and the subsequently achieved consensus values were used as the input parameters for the model. Second, the results of the model underwent rigorous testing of its robustness by the means of extensive sensitivity tests. Third, the model was documented in detail in a working paper and thus all assumptions were made transparent (Holthausen et al., 2009).

One of the strongest simplifications was to assume identical probabilities and consequences for all considered property types (i.e. residential, office and retail). A differentiation, i.e. an estimation of the parameters for each property type, would present a desirable further development of the model. In the following, the three central elements of ESI® Risk Model – scenarios, probabilities and consequences – will be described briefly.

Scenarios. Changes in framework conditions result in changes concerning the requirements for property. For example, future rising energy prices will require properties to meet higher standards with regard to energy efficiency. The extent of the possible requirements was described for each partial indicator by the means of four scenarios: A realistic maximum scenario, a medium scenario, a minimum scenario and a zero scenario are specified for every case. For example, it is possible that as a result of a future rise in energy prices the market demands zero energy houses (maximum scenario), Minergie-P® houses (medium scenario), Minergie® houses (minimum scenario) or no increased energy efficiency (zero scenario).

Probabilities. Probabilities of occurrence are assigned to all of the scenarios. It is assumed that the actual development in the remaining building lifetime can be allocated to one of the scenarios. In order to quantify the parameters of the model, the probabilities (and the consequences) were estimated and then validated by a group of leading property experts. To do so, the experts initially estimated the probabilities and the consequences of the scenarios independently of each other and subsequently validated the results as a group. I.e. the assignment of the probabilities (and the consequences) was based on subjective assessments in form of a consensus among experts.

Consequences as a Proportion of the Property Values. The consequences of the scenarios are indicated as a proportion of the property value in order to obtain results which are independent of the property size. In order to implement this as a model, the following assumptions were made or the following model properties specified:

– Whenever possible, the consequences were estimated on the bases of the estimated costs to refurbish the property due to the new requirements as laid out by the scenarios. If the new requirements could not be addressed by refurbishing (e.g. in the case of location-related features) then the consequences were estimated based on the expected loss of rental return.

- In the cases where refurbishment costs were estimated, the estimates were carried out as a proportion of the building value in a first step and were then extrapolated to the total property value. In able to do this it is necessary to assume a relation between value of the building and value of the land. As a rule of thumb it is assumed that 65% of the value of the property is based on the value of the building and 35% is accounted for by the value of the land (based on empirical findings for Switzerland (Kubli et al., 2008)).
- The changes in the exogenous framework conditions which cause a shift in the properties' financial value often occur by single events. As in the net present value method the events are entered in the risk model as the annual expectation value of the consequences associated with the respective scenario.
- The value of the consequences of the scenarios is discounted to their present value.[19]
- Therefore, the assumed point in time the event occurs has a considerable impact on the net present value. In the risk model, this is considered by varying the point in time the event occurs within the considered range of 11 to 40 years by the means of a Monte Carlo simulation – i.e. by computer based repeated random sampling. Thus a realistic expected value of the consequences of each scenario can be calculated.

The weighting of the partial indicators is derived from the size of the spread of the risk between the best possible and worst possible specification of the partial indicators (e.g. the difference between the risk of a zero energy house and a building without increased energy efficiency). The weighting for each sustainability feature is undertaken by adding up the spreads for the partial indicators.[20] The model-based weighting of the property features is illustrated in the distribution shown in Figure 2.

In order to determine the weighting of the ESI®-Indicator when it is integrated in the DCF method, the maximum over- and underestimation in value are quantified. To this means, the expected costs on the basis of negative values for all the partial indicators are linked to determine the maximally possible over-estimation of the value of property by using DCF. This represents the discounted future costs which are expected but not taken into account in the DCF method (in proportion to the value of the property), and which occur as a result of changes expected in the exogenous framework conditions. On the other hand, the maximum possible underestimation in value by using DCF is determined by linking the most favourable values for all the partial indicators.[21]

The maximum influence of the ESI®-Indicator with regard to an over- or underestimation of the property value by neglecting the sustainability aspects taken into account in the indicator amounts to -14.9% or +6.6% of the property value.

The robustness of the model was tested by the means of extensive sensitivity analyses.[22] The results are presented in the Tables 3 and 4. The variation coefficients in Table 3 show that the partial indicators with the absolute highest weights also have a relatively higher accuracy of estimation. Overall, the sensitivity analyses demonstrate that the model is sufficiently robust.

Based on the weighting, it is possible to calculate the ESI® Risk Component for the discount rate (the calculation is described in the subsequent practical example). It is generally used in addition to the existing risk components. As already mentioned, because the determination of the discount rate and the risk component are often not undertaken uniformly in Switzerland and are often not transparent, it is recommended that this step is verified on a case by case basis in order to avoid improbable but nevertheless possible overlapping.

3.4 Practical Application of ESI® Property Valuation

During the last 1.5 years practical tests have been carried out on approximately 200 properties (apartment buildings, offices and sales properties as well as properties for mixed use). The properties came from the portfolios of 8 different private and public owners and included investments properties as well as corporate real estate.[23] The valuations were carried out either by the owners or by external certified valuators. In the following, the application of the ESI® Property Valuation is illustrated first by means of a concrete example of an object and then of a small portfolio.

Practical Example Apartment Building: The object in question is an apartment building located in Central Switzerland (a more detailed description of the object is given in Figure 3). In a first step, the ESI®-Indicator is determined. As the radar diagram in Figure 3 demonstrates at a glance, the property's sustainability performance concerning flexibility and polyvalence, accessibility and mobility, as well as health and comfort are very good. The property performs well concerning energy and water dependency as well as safety and security. The detailed calculation of the ESI®-Indicator is illustrated in Table 5. The overall application of the ESI®-Indicator to the property results in a value of +0.5. This corresponds to an over-average sustainability assessment. In addition to the sustainability performance, measures to increase the value of a property can be derived from the results. Possible potential for improvement has been identified for the features energy and water dependency as well as for security (see Figure 3).

In the second step, the results of the ESI®-Indicator are used to determine the ESI® Value based on a conventional DCF valuation. To calculate the correction factor the ESI®-Indicator with the value of +0.5 is multiplied with the weighting factor of +6.6% (which corresponds to the estimated overestimation of property value, see chapter 3.3.3). This calculation amounts to a correction factor of 3.3% and therefore results in an increase of the current market value by 3.3%. By applying the correction factor to the discount rate from the conventional DCF valuation the ESI® Risk Component can be calculated (in a backward calculation[24]). In this case it amounts to -0.14%. The ESI® Discount Rate from the ESI® Valuation consists of the following components:

Risk-free base rate (nominal): 3.00%

Inflation rate:	-1.20%
General real estate risk:	2.10%
Property specific risk:	0.40%
Conventional discount rate (DCF):	**4.30%**
ESI® Risk Component:	-0.14%
ESI® Discount Rate:	**4.16%**

In this example the apartment building's market value was estimated at CHF 28,190,000 by the means of a conventional DCF valuation. Therefore, the correction of 3.3% amounts to CHF 930,270 and results in the ESI® Value of CHF 29,120,270 incorporating the weighted ESI®-Indicator of +0.5 in the discount rate.

Practical Example Portfolio: Table 6 presents the results of the ESI® Valuation for a small portfolio belonging to a private investor. The portfolio consists of 11 apartment buildings and one construction project. The ESI®-Indicators over the whole portfolio average to 0.03. This corresponds to an average sustainability performance of the portfolio. The absolute value of the added nominal deviation from conventional valuation (the sum of the respective over- and underestimations) amounts to CHF 5,432,307. This can be interpreted as the total error margin of the conventional DCF valuation compared to the ESI® Property Valuation for this small portfolio. In sum, the value of the portfolio is corrected by -0.99%.

Overall, the practical tests applied to the approximately 200 properties suggest that ESI® Valuation yields plausible results and that its implementation is practicable. They have shown that on average it is possible to determine the ESI®-Indicator in two hours. The range lies within half an hour to three hours per property depending on the quality of the plans and whether an on-site inspection of the property is necessary.

4 Conclusions and Further Research

4.1 Opportunities and Limits of the Approach

ESI® Property Valuation combines an academic approach with practicality. It is an attempt to contribute to making the "Valuation Black Box" more transparent. The ESI®-Indicator anticipates and quantifies the consequences of long-term changes such as rising energy prices, demographic and climate change on the worth of property. It thereby provides the necessary quantitative, risk-based information for valuers who wish to reduce the valuation lag, i.e. the tendency of valuations to lag behind market trends. However, the approach has its limitations. It can not change the fact that every property valuation essentially is nothing but an estimation on the basis of certain assumptions and comparisons, meaning that the potential for uncertainty remains high. Therefore, despite aiming at reducing the error of margin inherent to every valuation, the problem of "Valuation Uncertainty" can not be resolved. The fact that several large investors in Switzerland have decided to valuate their portfolios with the ESI® Valuation and have commissioned their external valuators to do so shows there is a real demand for integration of value-relevant sustainability features in valuation.

4.2 Outlook

In principle, ESI® Property Valuation can be applied in any country. The selection of the sustainability features and in particular the operationalisation of the ESI®-Indicator however must be adjusted to national circumstances. The ESI®-Indicator presented here was developed for Switzerland. Adaptations to other property markets and to their specific characteristics and framework conditions may be necessary before applying ESI® to other countries. Moreover, further empirical evidence is needed to test the impact of the sustainability features identified by the ESI®-Indicator, e.g. by integrating and testing these features in hedonic models (as has been carried out for energy-efficiency).

Furthermore, a comparison of the results of the ESI® valuation and the actual sales priced needs to be conducted to provide empirical evidence about the plausibility of the ESI® valuation.

It also needs to be investigated how a property valued as sustainable in accordance with ESI® can be compared in detail with a LEED/BREEAM certification or be classified as the latter. Another point to review is whether the weighting of the sustainability features should differ for different kinds of building types. Finally, ESI® Valuation was developed as a supplement to the DCF method used for investment property. It still needs to be clarified how sustainability aspects can be integrated in other valuation methods, which are currently being used.

The results of this paper do not only contribute to the ongoing debate on sustainability and valuation, but also for other aspects of property management. Knowing which property features contribute to the value of a property in the long term is relevant to almost every decision during the life cycle of a property: during the planning and building stage, as well as when making renovation and dismantling decisions, or in purchase and sales decisions.

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Endnotes

1. Energy Star is a joint program of the U.S. Environmental Protection Agency and the U.S. Department of Energy to protect the environment through energy efficient products and practices.
2. LEED (Leadership in Energy and Environmental Design) is an internationally recognized green building certification system developed by the U.S. Green Building Council.
3. DGNB (Deutsche Gesellschaft für Nachhaltiges Bauen): http://www.dgnb.de/
4. Minergie® is a registered sustainability brand for new and refurbished buildings. Minergie® focuses on the comfort of the users living or working in the building. The regular Minergie®-Standard requires that general energy consumption must not to be higher than 75% of that of average buildings. Minergie-P® defines buildings with very low energy consumption. Minergie-ECO® adds ecological requirements such as indoor air quality, noise protection etc. to the regular Minergie®-Requirements.
5. In addition to the financial barriers this paper focuses on, there are also social and psychological barriers, which have to be overcome for a rapid and broad acceptance of sustainable buildings. They are divided into individual organizational and institutional barriers by (Hoffman and Henn, 2008).
6. Another explanation why investors may be slow in implementing energy efficient buildings is that in a lifecycle costs perspective energy costs for electricity, heating and cooling purposes as part of the utility costs is of minor importance. Stoy (2005) showed that the costs of utilities and waste disposal represents only approximately 22% of the affecting expenses. With a data pool of 105 Swiss office buildings (Stoy and Kytzia, 2008) illustrate the importance of the electricity costs (50%) for the costs of utilities and waste disposal. In contrast, the waste water, water, and heating costs are of minor significance. Kats (2003) drew similar conclusions on “green buildings“

in the report to California’s Sustainable Building Task Force. This situation is aggravated when owner and occupier are not congruent, as the investor bears the higher investments and the benefits (in the form of lower energy costs) are reaped by the occupier.

7. A useful overview of commonly used value definitions is given in Tegova (The European Group of Valuars´ Associations, 2009)
8. There is a large body of literature that gives useful overviews of common valuation methods (e.g. Diederichs, 2006, The Appraisal Institute, 1996).
9. The residual value corresponds to the summarized value of all cash-flows for the remaining years of a property after a certain period under consideration.
10. Traditionally, valuation literature has not presented the built-up method as a viable method for deriving discount and yield rates. The 6. and 7. editions of the *Appraisal of Real Estate* stated that “because of the intangible character of the components, the built-up method is not considered a valid procedure through which a specific rate may derived.” With the securitization of real estate investment and new methodologies to rate the risk associated with commercial real estate properties, however, some analysts have called for a reconsideration of built-up rates. (Appraisal Institute, 1996)
11. See also Meins, Erika, (2009) and (forthcoming).
12. The author is well aware of the fact that sustainability ideally should be defined in a more holistic way and not focus on one main aspect like it is done here (see chapter 1).
13. For a detailed discussion of this selection process please refer to Meins and Burkhard (2009).
14. Experts representing amongst others: 1) Iván Antón, Project leader sustainability from a leading Swiss consultancy firm with focus on the property and construction

sector, 2) Thorsten Busch, Senior consultant of a consultancy firm with focus on real estate management, 3) Niels Holthausen, Risk expert of an international engineering, planning and consulting company, 4) Andreas Pfeiffer, Area manager energy & environment of a planning office with focus on services to do with building technology, 5) Rolf Truninger, Managing Director of a consultancy firm with focus on real estate controlling & risk management.

15. Scientists representing amongst others: 1) Hans-Peter Burkhard, Director of the Centre for Corporate Responsibility and Sustainability at the University of Zurich, 2) Roland Stulz, Executive Director of Novatlantis, the flagship of the Swiss Federal Institute of Technology domain for the 2000-watt society, 3) Holger Wallbaum, Chair of Sustainable Construction at the Swiss Federal Institute of Technology Zurich.
16. Decentrally renewable energy means that energy production is divided into various locations and is not controlled only by one single location. A solar panel on the roof of a building is an example of a decentrally renewable energy source.
17. The coding of all the partial indicators is apparent in the software. The software is available from QualiCasa AG.
18. Niels Holthausen and Peter Christen from Ernst Basler + Partners AG are experts for risk-based modelling of the consequences of natural catastrophes.
19. A discount rate of 4.7% was used, which corresponds to a long-term empirical value from Swiss property valuation practice.
20. This is only possible without any distortion if the potential figures for all the partial indicators taken into account are actually also possible at the same time, i.e. that there is no overlapping of the figures. For this reason partial indicators are sometimes combined (example: wide doors, wide corridors, wheelchair accessible bathroom/toilet).

21. The link is made via a progressive multiplication of the changes in value indicated as a proportion of the property value by the favourable or unfavourable specification with regard to the relevant partial indicator. In doing so at each stage the amended real estate value is used, which has already been determined by taking into account the other partial indicators. Cost-relevant synergies, which may result from various renovations completed at the same time, are used as a basis to estimate each partial indicator and are included in the calculation as a reduction factor.
22. Sensitivity analyses: The spreads of each partial indicator were varied by +/- 50% for the probability of the scenarios and by +/-25% for the consequences by the means of a Monte Carlo Simulation. A triangular distribution with the given value as the most likely mean was assumed. In the same way the assumed discount rate was also varied: from 4% to 5.4%. The results of the effects of the variation on the weighting are presented in Tables 3 and 4.
23. The practical tests were carried out on property belonging to ABZ (Allgemeine Baugenossenschaft Zürich), Implenia/Reuss Engineering AG, Migros Genossenschaftsbund, Nest Sammelstiftung, the City of Zurich (property management), SUVA, Swiss Life Property Management AG as well as ZKB (Zürcher Kantonalbank).
24. Since the weight to incorporate the ESI®-Indicator is relative to the total value, the correction is not calculated by means of the discount rate. Optionally, in a backwards calculation, this can be done, e.g. if the valuer would like to display the ESI® Risk Component as an additional information.

Table 1: Sustainability features from a financial point of view

Sustainability features	External conditions
1. Flexibility and polyvalence 1.1 Flexibility of use 1.2 Adaptability to users	Demographics, structure of households
2. Energy and water dependency 2.1 Energy demand and production 2.2 Water use and wastewater disposal	Climate change, energy and water prices
3. Accessibility and mobility 3.1 Public transport 3.2 Pedestrians and non-motorized vehicles 3.3 Accessibility	Percentage of aged population, cost of fossil fuels
4. Safety / security 4.1 Location regarding natural hazards 4.2 Building safety and security measures	Climate change, need for safety and security
5. Health and comfort 5.1 Inside air quality 5.2 Noise 5.3 Daylight 5.4 Radiation 5.5 Ecological construction materials	Need for safety, health awareness, building services

Table 2: Specification of CCRS Economic Sustainability Indicator ESI®

Sustainability features	Partial indicators	Apartment building	Office	Retail
1. Flexibility and Polyvalence	1.1 Flexibility of use			
	1.1.1 Floor plan	x	x	x
	1.1.2 Storey height	x	x	x
	1.1.3 Accessibility, reserve capacity, and wiring / pipes / building services	x	x	x
	1.2 Adaptability to users			
	1.2.1 Wheelchair accessibility	x	x	x
	1.2.6 Flexibility of kitchen layout	x		
	1.2.7 Room for storage of walker / pram	x		
	1.2.8 Balcony with window	x		
	1.2.9 Usability of outside space	x		
2. Energy and Water Dependency	2.1 Energy			
	2.1.1 Energy	x	x	x
	2.1.2 Locally produced renewable energy	x	x	x
	2.2 Water			
	2.2.1 Water use	x	x	x
	2.2.2 Wastewater disposal	x	x	x
	2.2.3 Rainwater use	x	x	x

3. Accessibility and Mobility	3.1 Public Transport	x	x	x
	3.1.1 Good connection to public transport			
	3.2 Non-motorized vehicles			
	3.2.1 Bicycle parking near the building	x	x	x
	3.3 Accessibility			
	3.3.1 Distance to local / regional centre			
	3.3.2 Distance to shops	x		
	3.3.3 Distance to local recreation area	x		
		x		
4. Safety and Security	4.1 Location regarding natural hazards			
	4.1.1 Location regarding natural hazards (Risk of floods, avalanches, landslides, collapse)	x	x	x
	4.2 Building safety and security measures			
	4.2.1 Object related safety and security measures	x	x	x
	4.2.2 Safety and security measures related to people	x x	x x	x x
5. Health and Comfort	5.1 Health and Comfort			
	5.1.1 Inside air quality	x	x	x
	5.1.2 Noise exposure	x	x	
	5.1.3 Sufficient natural light	x	x	
	5.1.4 Radiation exposure	x	x	x
	5.1.5 Ecological construction materials	x	x	x

Table 3: Sensitivity Analysis 1

	Quantiles							Standard	Mean	Coefficient
	0%	10%	25%	50%	75%	90%	100%	deviation		of variation
Period under consideration 40 years, variation of bank rate, variation of time of occurrence										
1. Flexibility und Polyvalence	19.0%	**35.0%**	38.5%	**42.6%**	46.7%	**50.3%**	67.7%	0.059	42.6%	**13.9%**
2. Energy and Water Depende	5.6%	**10.8%**	12.9%	**16.1%**	20.1%	**23.5%**	38.6%	0.048	16.7%	**29.0%**
3. Accessibility and Mobility	2.8%	**6.0%**	7.3%	**9.1%**	11.2%	**13.3%**	23.8%	0.028	9.4%	**29.7%**
4. Safety and Security	1.6%	**4.2%**	5.1%	**6.5%**	8.0%	**9.6%**	18.5%	0.021	6.7%	**31.3%**
5. Health and Comfort	10.5%	**19.1%**	21.5%	**24.3%**	27.4%	**30.3%**	48.2%	0.044	24.6%	**17.7%**

Table 4: Sensitivity Analysis 2

	Quantiles							Standard	Mean	Coefficient
	0%	10%	25%	50%	75%	90%	100%	deviation		of variation
Period under consideration 40 years, variation of bank rate, variation of time of occurrence										
1. Flexibility und Polyvalence	19.0%	**35.0%**	38.5%	**42.6%**	46.7%	**50.3%**	67.7%	0.059	42.6%	**13.9%**
2. Energy and Water Depende	5.6%	**10.8%**	12.9%	**16.1%**	20.1%	**23.5%**	38.6%	0.048	16.7%	**29.0%**
3. Accessibility and Mobility	2.8%	**6.0%**	7.3%	**9.1%**	11.2%	**13.3%**	23.8%	0.028	9.4%	**29.7%**
4. Safety and Security	1.6%	**4.2%**	5.1%	**6.5%**	8.0%	**9.6%**	18.5%	0.021	6.7%	**31.3%**
5. Health and Comfort	10.5%	**19.1%**	21.5%	**24.3%**	27.4%	**30.3%**	48.2%	0.044	24.6%	**17.7%**

Table 5: Detailed determination of ESI®-Indicator for the practical example

Sustainability features	Partial indicators	Appartment Building Central Switzerland	Weighting %
1. Flexibility and Polyvalence	**1.1 Flexibility of use**		
	1.1.1 Floor plan	1	
	1.1.2 Storey height	0	
	1.1.3 Accessibility wiring / pipes / building services	1	
	1.1.4 Reserve capacity wiring / pipes / building services	1	
	Average (Min:-1 / Max: 1)	**0.8**	
	1.2 Adaptability to users		
	1.2.1 Lift existing for all stories if multi-story	1	
	1.2.2 Manageable differences in height, interior and exterior	1	
	1.2.3 Sufficiently wide doors	0	
	1.2.4 Sufficiently wide halls	-1	
	1.2.5 Wheelchair accessible washrooms	-1	
	1.2.6 Flexibility of kitchen layout	1	
	1.2.7 Room for storage of walker / pram	1	
	1.2.8 Balcony with window	1	
	1.2.9 Usability of outside space	1	
	Average (Min:-1 / Max: 1)	**0.4**	
	Average 1.1 / 1.2	**0.6**	42.6
2. Energy and Water Dependency	**2.1 Energy**		
	2.1.1 Energy demand		
	2.1.1.1 Hot water usage in MJ/m^2a	0	
	2.1.1.2 Cooling	1	
	2.1.2 Locally produced renewable energy		
	2.1.2.1 To cover all warming needs	-1	
	2.1.2.2 To cover all electrical needs	-1	
	Average (Min:-1 / Max: 1)	**-0.3**	
	2.2 Water		
	2.2.1 Water use	1	
	2.2.2 Wastewater disposal	1	
	2.2.3 Rainwater use	-1	
	Average (Min:-1 / Max: 1)	**0.3**	
	Average 2.1 / 2.2	**0.0**	16.7
3. Accessibility and Mobility	**3.1 Public Transport**		
	3.1.1 Good connection to public transport		
	3.1.1.1 Distance bus/tram	1	
	3.1.1.2 Distance rapid-transit railway/train	1	
	3.1.1.3 Frequency bus/tram	1	
	3.1.1.4 Frequency rapid-transit railway/train	1	
	Average (Min:-1 / Max: 1)	**1.0**	
	3.2 Non-motorized vehicles		
	3.2.1 Bicycle parking near the building	0	
	Average (Min:-1 / Max: 1)	**0.0**	
	3.3 Accessibility		
	3.3.1 Distance to local / regional centre	1	
	3.3.2 Distance to shops	1	
	3.3.3 Distance to local recreation area	1	
	Average (Min:-1 / Max: 1)	**1.0**	
	Average 3.1 / 3.2 / 3.3	**0.7**	9.4

Sustainability features	Partial indicators	Appartment Building Central Switzerland	Weighting %
4. Safety and Security	**4.1 Location regarding natural hazards**		
	4.1.1 Location regarding natural hazards (Risk of floods,	-1	
	Average (Min:-1 / Max: 1)	**-1.0**	
	4.2 Building safety and security measures		
	4.2.1 Object related safety and security measures		
	4.2.1.1 Fill out only for flooding danger:	1	
	4.2.2 Safety and security measures related to people		
	4.2.2.1 Lightning / illumination	1	
	4.2.2.2 Fill out only for buildings built in 1985: Fire protection	-	
	Average (Min:-1 / Max: 1)	**1.0**	
	Average 4.1 / 4.2	**0.0**	6.7
5. Health and Comfort	**5.1 Health and Comfort**		
	5.1.1 Inside air quality	-1	
	5.1.2 Noise exposure		
	5.1.2.1 Ventilation comfort	-1	
	5.1.2.2 Interior noise exposure / acoustics		
	a) Airborne sound	1	
	b) Impact sound	1	
	c) Noise from building service equipment and tighter builidng	1	
	5.1.3 Sufficient natural light	1	
	5.1.4 Radiation exposure		
	5.1.4.1 Electromagnetic pollution (non-ionizing)	1	
	5.1.4.2 Radon (ionizing)	1	
	5.1.5 Ecological construction materials		
	5.1.5.1 With alterations and new additions	0	
	5.1.5.2 Material with adverse health effects	-	
	Average (Min:-1 / Max: 1)	**0.6**	24.6
Sustainability Indicator ESI®	**Weighted average (Min:-1 / Max: 1)**	**0.5**	

Table 6: Practical example: portfolio with 12 objects

Location	North Switzerland	East Switzerland	West Switzerland	East Switzerland	Central Switzerland	Central Switzerland
Property Description	Total 165 apartments. Built in 1969 and completely refurbished in 2003. The apartments are in good condition and have a normal standard.	Apartment building with 2 entrances and huge living space. Good overall condition of the object.	Former workers' housing estate consisting of 152 apartments with small rooms and bad furnished kitchen. The apartments are in bad condition.	The apartments have huge balconies and the basic structure of the houses is in a good condition.	Good overall condition of the object. Small floor planes, which are not modern anymore.	The apartments have a modern standard of fittings. The kitchens and sanitary facilities are very modern. The property is in a very good condition.
Conventional Valuation						
Conventional Market Value	35,670,000	4,650,000	23,740,000	4,907,000	29,010,000	28,190,000
ESI® Valuation						
CCRS Economic Sustainability Indicator ESI®	0.1	0.0	-0.6	0.2	-0.2	0.5
Correction Factor [%]	0.66	0.00	-8.94	1.32	-2.98	3.30
Nominal Deviation from Standard Valuation [CHF]	235,422	0	-2,122,356	64,772	-864,498	930,270
ESI® Value [CHF]	3,590,5422	4,650,000	21,617,644	4,971,772	28,145,502	29,120,270

Apartment Building	7	8	9	10	11	Construction Project
Location	South Switzerland	East Switzerland	West Switzerland	East Switzerland	Central Switzerland	East Switzerland
Property Description	Normal floor plans and attractive living rooms with chimney and balcony.	Modern floor planes with consequent separation of living and sleeping area. The building is in a good condition. Heating system and façade are refurbished.	The apartments have private terraces or balconies but inefficient created floor plans. The overall condition of the object is good with small defects.		2 apartment buildings with total 18 apartments in favored location with nice view.	Land ripe for development, but not overbuild yet. Located in a residential area with good sun conditions and good connection to the public traffic.
Conventional Valuation						
Conventional Market Value	7,900,000	10,227,000	15,060,000	40,460,000	5,560,000	13,010,050
ESI® Valuation						
CCRS Economic Sustainability Indicator ESI®	-0.2	-0.2	0.1	0.2	-0.1	0.5
Correction Factor [%]	-2.98	-2.98	0.66	1.32	-1.49	3.30
Nominal Deviation from Standard Valuation [CHF]	-235,420	-304,764.6	99,396	534,072	-82,844	429,331
ESI® Value [CHF]	7,664,580	9,922,235	15,159,396	40,994,072	5,477,156	13,439,381

Average CCRS Economic Sustainability Indicator ESI®	0.03
Average Correction Factor [%]	-0.73
Absolute Value of Added Nominal Deviation from Standard Valuation [CHF]	5,432,306.65
Total Conventional Market Value [CHF]	218,384,050
Total ESI® Value [CHF]	217,067,431.45
Overall Change in Value [%]	-0.99

Figures

Figure 1: Property value as determined using the DCF method, both with and without ESI®-Indicator Source: (Holthausen et al., 2009)

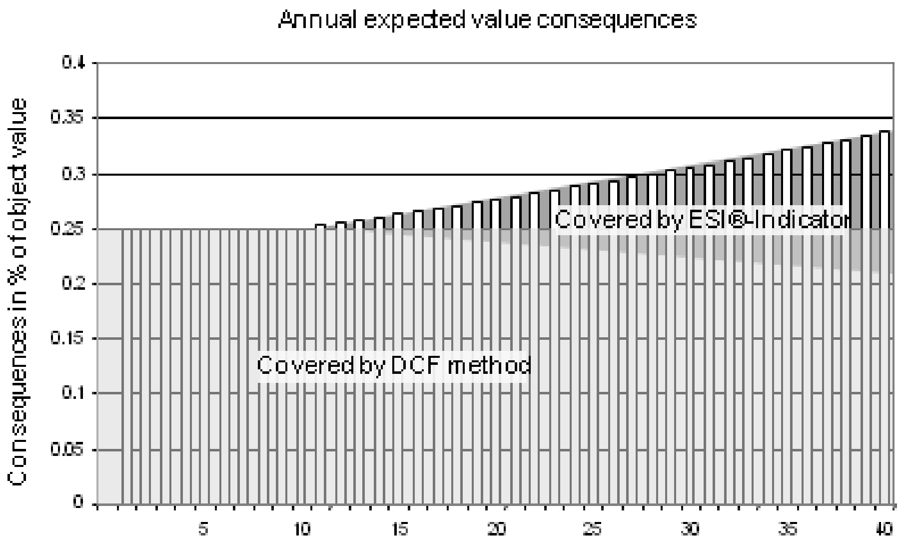


Figure 2: Weighting of partial indicators

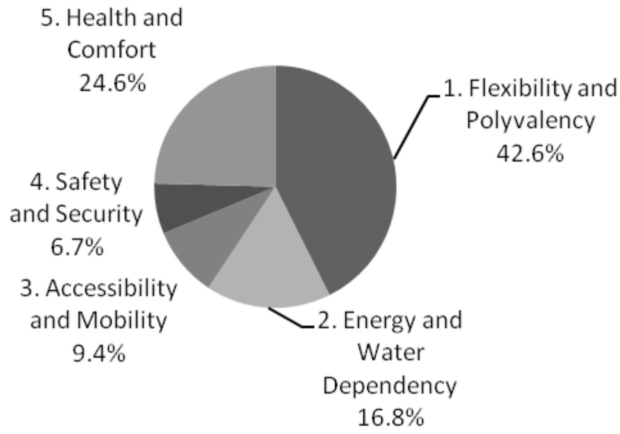


Figure 3: Practical example: apartment building Central Switzerland

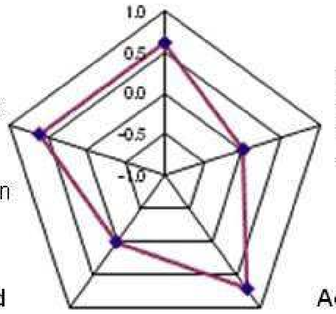
Object Description

The multi-family house consists of two free-standing L-shaped structures, which have been developed from two attached buildings for residential accommodation. The apartments have a modern standard of fittings. The kitchens and sanitary facilities are very modern. The buildings provide a modern impression both from the inside and outside. The surrounding areas are well-kept. The property is in a very good condition.

Results ESI®-Indicator and Suggestions for Measures to Improve Value

Flexibility and Polyvalence
Can be improved through:
- Sufficiently wide aisles
- Wheelchair accessible restrooms

Health and Comfort
Can be improved through:
- Installation of comfort ventilation
- Improved noise protection



Energy and Water Dependency
Can be improved through:
- Utilization of rain water for toilets and irrigation

Safety and Security

Accessibility and Mobility

ESI® Real Estate Valuation

Conventional Market Value (DCF – Standard Valuation)	CHF 28,190,000
CCRS Economic Sustainability Indicator ESI®	**0.5**
Correction Factor	3.3%
Nominal Deviation from Standard Valuation	CHF 930,270
ESI® Value	**CHF 29,120,270**

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