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VREDNOTENJE
VEČNADSTROPNIH
AVSTRIJSKIH PASIVNIH
STANOVANJSKIH ZGRADB PO
VSELITVI

*POST-OCCUPANCY EVALUATION
(POE) OF MULTISTOREY
AUSTRIAN PASSIVE HOUSING
PROPERTIES*



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VREDNOTENJE VEČNADSTROPNIH AVSTRIJSKIH PASIVNIH STANOVANJSKIH ZGRADB PO VSELITVI

POST-OCCUPANCY EVALUATION OF MULTISTOREY AUSTRIAN PASSIVE HOUSING PROPERTIES

izvleček

V okoliščinah podnebnih sprememb je trajnostna stanovanjska gradnja postala politični program. Ključno vprašanje pri uresničevanju koncepta trajnostne gradnje v primeru pasivnih stanovanjskih hiš je, kako uporabniki takšne hiše sprejemajo. Vrednotenje po vselitvi je raziskovalna tehnika, ki nudi reprezentativna mnenja uporabnikov glede inovacij v stanovanjski gradnji.

Članek razčlenjuje vrsto VPV-jev iz obdobja 2007-2008, ki zadevajo prve komplekse pasivnih stanovanjskih hiš v Avstriji. Na anketo v pisni obliki je odgovorilo 324 stanovalcev. Na ta način so bili zbrani socio-demografski podatki v zvezi z zadovoljstvom, kakovostjo stanovanjskega objekta, motiviranostjo za varčevanje z energijo, problemi z ogrevanjem in prezračevanjem in drugimi vidiki. Ob tem je bil predmet preučevanja tudi 244 običajnih stanovanjskih enot na Dunaju in v Salzburgu (kontrolna skupina). Trije dunajski projekti PSH so bili višjega bivanjskega standarda, šlo je namreč za enodružinske stanovanjske hiše. Manj kot 50% se jih je odločilo za stanovanje zato, ker je bilo v pasivni stanovanjski hiši. Po nekajmesečni izkušnji je 75-85% pasivna hiša postala všeč.

ključne besede

pasivne stanovanjske hiše, vrednotenje po vselitvi, potrebe uporabnikov, informacije o uporabniku, Avstrija

abstract

Under climate change conditions, sustainable housing has become a political agenda. A key issue for the implementation of sustainable building concepts like passive housing is their user acceptance. Post-occupancy evaluation, provides representative user opinions about housing innovations.

The article analyzes a 2007-2008 POE series about the first multistorey passive housing complexes at Austria, eight properties in Vienna and Salzburg City with 577 housing units. A written user survey, answered by 324, collected sociodemographic data on well-being, housing quality criteria, motivation to save energy, information on versus problems with heating and ventilation system. A control group of 244 conventional housing units was studied parallel.

Three Vienna PH projects were on a high level of well-being like detached single housing. Less than 50% had chosen their flat because it was passive housing. After several months of experience, 75-85% liked PH. Handling problems with the PH technology were reported especially in the first time period after moving in. The main issue of successful PH identification was the repeated dialogue with management and technicians.

key words

Passive housing, Post-occupancy evaluation, user needs, user information, Austria

Social Design and its evaluation methods of UNA (user need analysis, before planning) and POE (post-occupancy evaluation, after construction), have a history of 30 years [Sommer, 1983; Marans, Spreckelmeyer, 1981; Preiser, Rabinowitz, White, 1988; Zimring, 2002; Preiser, Vischer, 2005], and led to international building studies, mostly in the Angloamerican world (USA, Canada, Australia, New Zealand, UK). European researchers were involved in the foundation of Architectural Psychology [Canter, 1970; Kueller, 1973], but evaluations remained experimental projects in Europe [e.g. review by Walden, 2008]. With social reactions to the climate change situation, sustainable housing became a political agenda. A key issue for the successful implementation of sustainable building concepts will be the user acceptance of new technologies like Passive Housing (PH).

Austrian POE pilot studies were started by psychologists and sociologists in the seventies [e.g. Guttmann, Maderthaner, 1974]. Reinhard Gieselmann, architect and professor for housing at the Vienna University of Technology, asked the author for a first POE in Vienna social housing in 1989. This led to a permanent cooperation with the institution which in 2004 hosted IAPS18 [Martens, Keul, 2005].

In 2000, the state-supported Austrian research focus „Building of Tomorrow“ and the Salzburg Chamber of Labour ordered a POE comparing four sustainable and four conventional housing projects -one a PH prototype- at Salzburg City [Keul, 2000a, 2000b].

Passive Housing (PH) and POE

Sustainable building and living has a high ecological impact. Heating is the dominant factor of the energy costs for an average household. The German engineer Wolfgang Feist

and his colleagues developed the European Passive House (Passivhaus, PH) standard of sustainable building quality [Feist, 1992]. Using a combination of optimum wall, roof and window insulation, solar building orientation and a ventilation system with heat recovery by heat exchange, it was possible to realize an energy demand level of 15 kWh/sqm/year. The first German Passive House 1991 gives room to four families at Darmstadt-Kranichstein, Hessen, Germany, and passed a POE [Rohrmann, 1994]. Further PH POE was done especially at Hessen, Germany [e.g. Flade, 1997].

Feist's research institute also paid attention to user behavior as a moderator variable [Passive House Institute, 1997]. However, at the low demand level around 15 kWh/sqm/year - compared to over 200 kWh/sqm/year in conventional housing -, user performance (heating, ventilation behavior) modifies PH energy efficiency to a lesser extent.

Austrian POE, first regarded as expensive prototype, gained importance when Passive Housing entered the mass market. After a test phase with mostly detached PH, the first multistorey PH properties at Vienna (Muehlweg, Utendorfgasse, Roschegasse, Dreherstrasse, Kammelmweg B & E) and Salzburg (Samer Moesl, Franz Ofner Strasse) with 577 housing units were occupied in 2006 and 2007. For the building industry and politics, low-energy mass housing is a chance to cut costs in accordance with the Kyoto Protocol, but also a risk to lose credibility and invested money in case of failing technology and user acceptance. This genuine innovation risk led to a revival of housing research and POE.

Project descriptions

PH project Vienna-Muehlweg (Figure 1a): In the northern

district Floridsdorf, architects Dietrich and Untertrifaller planned a partly wooden combined structure of five floors occupied in late 2006. POE-1 was done in spring of 2007 (66% return), POE-2 followed in spring of 2010 (77%).



Slika 1 a-b: PSH na Dunaju, Muehlweg in Utendorfasse.

Figure 1 a-b: Vienna PH properties Muehlweg und Utendorfasse.

PH project Vienna-Utendorfasse (Figure 1b): Near the Western railroad line in the western district Huetteldorf, architects Schoeberl, Poell and Kuzmich planned a concrete structure of five floors, occupied in late 2006. POE-1 followed in May 2007 (79% return), POE-2 in November 2008 used telephone interviews (77% return).

PH project Vienna-Roschegasse: In the southeastern district Simmering, architects Treberspurg and partners planned a concrete structure of five floors. The city block row structure around two yards opened in late 2006. POE documented the status in May 2007 (40% return).

PH project Vienna-Dreherstrasse (Figure 1c): At the southeastern district Simmering, architect Lautner planned an estate of five roundish concrete structures, one of them a PH of five floors. It entered the market in fall 2007. BUWOG did an internal POE after seven months [Kurzmann, 2008].

PH projects Vienna-Kammelmweg-B and -E: In the northern district Floridsdorf, architects Schindler & Szedenik (B) and

Kaufmann (E) planned two concrete structures of seven floors, occupied in late 2007. POE came after seven months (64% return B, 49% return E).



Slika 1 c-d: PSH v Dreherstrasse (Dunaj), Samer Moesl (Salzburg).

Figure 1 c-d: PH properties Dreherstrasse (Vienna), Samer Moesl (Salzburg).

PH project Salzburg-Samer Moesl (Figure 1d): In the northern Gnigl district, architect Speigner planned a wooden structure of three floors. The structure with three building rows opened in fall 2006. POE was done in May 2008 (80% return).

PH project Franz-Ofner-Strasse: In the Itzling district, architects Mayer and Seidl planned a concrete structure of six floors, occupied in late 2007, evaluated in late 2008 (57% return).

The eight Austrian PH objects had similar PHPP (=passive house projecting package) heating model computation results and favorable Blower Door building density records (details see www.igpassivhaus.at). Five PH properties have central ventilation systems, decentralized ventilation is used at three (see Table 1). Air temperature regulation uses heat recovery systems with heat exchangers. Technical details of several projects were documented at www.hausderzukunft.at/english.htm. Building physicists started measurements of temperature and humidity with data loggers in several places. As POE data are not longitudinal, but cross-sectional, aggregate, subjective

data, they cannot be directly matched with the logger data unless in special housing experiments.

PH POE questions

Passive Housing technology is at first sight unusual for laypeople and not self-explanatory. European housing occupants are accustomed to wall sockets, light switches, to wall or radiator thermostats, but not to a central heating and ventilation instrument (see Figure 2a) and to air inlet and outlet valves outside bathrooms (see Figure 2b, both from PH Utendorfasse).



Slika 2: Napravi za upravljanje PSH in vhodni in izhodni zracni ventil PSH.
Figure 2: PH operating instruments and PH air outlet/inlet valves.

First-time users need information on the PH system, its energy-saving heat recovery mechanism and on optimum user behavior in the system. Therefore, PH technology is a psychological case for Lay theories [Furnham, 1988], Mental models [Gentner, Stevens, 1983], and the Diffusion of Innovations [Rogers, 1995]: To have success, the PH innovation should not be too complex, should enable user trials and observation. PH POE is an important tool to test supporting and obstructing factors for PH market introduction [Biermayr et al., 2001].

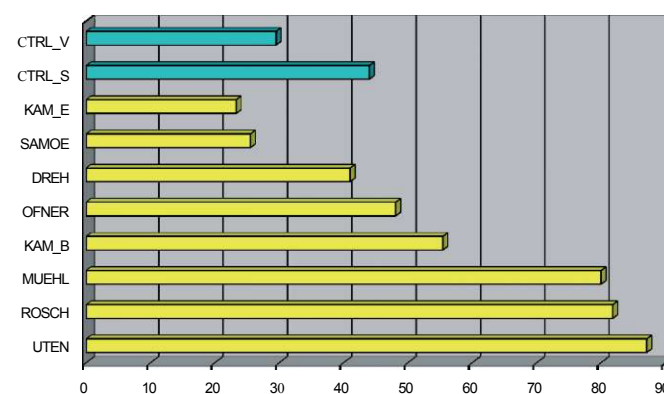
The standard PH POE method was a sent-out two-page questionnaire which was either collected personally or asked for in a reminder letter. POE-2 at Utendorfasse used telephone interviews. The author's POE questionnaire had between 35 and 44 items, consisted of 5 to 8 sociodemographic items, 11 to 18 open (qualitative) and 18 to 24 closed (quantitative) questions. A core of 19 items remained the same for the eight projects, other items were project-specific. PH Dreherstrasse was evaluated by an internal instrument of the Cooperative - 28 items, i.e. 1 sociodemographic, 15 open and 12 closed questions. It was up to the respondents who answered the questions. A more formal and hypothesis-driven POE overview is presented in Keul [2010].

Two control groups of conventional housing units were evaluated in 2008 and 2009: 156 questionnaires came from Vienna detached, row and multistorey buildings, 88 from Salzburg City. With higher times of residence, the age means were higher (Table 1).

PH POE results

General results Return rates were between 50 and 80%. The questionnaires were filled in by 40 to 70% female respondents (Table 1). The mean resident age was between 34.5 and 41.3, the age range between 19 and 82 years. The mean household size was between 2.1 and 3.1. Two person-households varied between 29% and 65%, households without children between 25% and 83% (Table 1). Mean apartment sizes ranged between 73 (Utendorfasse) and 94 square meters (Kammelmweg B).

Mean housing satisfaction, measured by a five-point Likert scale, was between 1.2 and 2.1 - the category "very satisfied" was used by 23 to 87 percent. Kammelmweg-E (23.3%) and Samer Moesl (25.5%) were lowest. Figure 3 shows the comparison with the two conventional control groups. Utendorfasse, Roschegasse and Muehlweg are in the high-satisfaction category, followed by Kammelmweg-B and Franz-Ofner-Strasse above the control level. Dreherstrasse is at the control level, Samer Moesl and Kammelmweg-E are even lower. Compared to the general Austrian housing satisfaction of 49% "very satisfied" for multistorey and 94% for detached houses [Ornetzeder, Rohrer, 2001], the Passive House user satisfaction was high for three properties, average for three, and low for two.



Slika 3: „Zelo visoka zadovoljnost" v odstotkih, PSH (rumeno) in naprave za upravljanje (modro).

Figure 3: Percentages of „very high housing satisfaction", PH (yellow) and controls (blue).

PH as a brand name in (social) housing?

The question "Do you know characteristics of a PH?" (PH-information% in Table 1) was answered with "yes" between 35% (Samer Moesl) and 94% (Dreherstrasse). In six of the eight properties, self-reported PH information was over 70%. A control question about the amount of heating costs saved in PH (none, under 50%, over 50%) was correctly answered by 45-50% (Samer Moesl, Kammelmweg-E) in projects with communication and motivation problems, but high - 85-92% (Roschegasse, Kammelmweg-B, Utendorfasse) - for well-informed PH residents.

Personal sympathy is a central feature of successful brands [Solomon, 1996]. Asked about sympathy for PH, two properties (Kammelmweg-E, Samer Moesl) ranked low (30-39%). Kammelmweg-B, Dreherstrasse, Muehlweg, Roschegasse, and Utendorfasse had sympathy values between 64 and 84%. Utendorfasse residents self-reported 84% sympathy in POE-1, and even 93% in POE-2 after one year.

Another brand feature is the recommendation of the product to friends. Asked about this, the best category ("very much") was low for Kammelmweg E (7%), Samer Moesl (19%) and Kammelmweg-B (32%) and high for Dreherstrasse, Utendorfasse and Roschegasse (53-60%).

Summing up, PH seems to have established brand quality in some properties (Muehlweg, Utendorfasse, Roschegasse, Dreherstrasse), but failed to do so in others (Kammelmweg-E, Samer Moesl).

PH energy saving as a resident attraction? PH is advertised as sustainable, energy saving housing. Whereas energy saving

in general shows a high social consent in European surveys (compare Table 1 Ener.sav.v.imp.%), it is still an open question whether it makes innovative housing attractive and promotes a "diffusion of innovation" [Rogers, 1995]. In the POE, it was asked whether PH was the "first choice feature" for residents (PH-preference % in Table 1) or whether other features (e.g. location) came first. There were high PH choice values (40-53%) for Muehlweg, Kammelweg-E and Dreherstrasse. Kammelweg-B (24%) and especially Utendorfgasse (7%) signalled low PH choice importance. Samer Moesl and Franz-Ofner-Strasse were "filled" by the Salzburg housing department, so the choice item was not applicable. As an indicator for "green behavior", only Kammelweg reported a higher-than-average permanent use of public transport (see Table 1).

Gender and generation perspective on PH? In all eight properties evaluated with the author's POE questionnaire, no gender effect was present with regard to housing satisfaction, PH knowledge, PH sympathy and energy saving. Of the eight analyzed projects, only Muehlweg showed a significant age effect (Kendall's tau=.376, p<.003) for PH knowledge which may be due to active PH selection by informed young people. Franz-Ofner-Strasse showed an unexpected significant age effect (Kendall's tau=-.280, p<.023) for PH sympathy - older residents expressed more sympathy.

PH heating and ventilation - easy user adaptation? An important point for successful PH performance is the perceived heating/ventilation quality and its user handling. Heating regulation problems and defects were reported after residents moved in - Samer Moesl 58%, Muehlweg 54%, Utendorfgasse 50%, Kammelweg-E 47%, Roschegasse 29%, Kammelweg-B 20%, Dreherstrasse 12%. Ventilation problems mostly dealt with noise and dry air, in some cases also with fogging (a black dust wall deposit) - Kammelweg-E 93%, Kammelweg-B 46%, Samer Moesl 42%, Dreherstrasse 30%, Roschegasse 25%, Utendorfgasse 24% (Table 1). At Kammelweg-E, the severe complaints led to measurements and a system improvement. PH user information - highlights and pitfalls? The eight planners and companies had different information concepts - mostly a mix of written material, resident meetings and on-site explanations (Tech-Med+ % at Table 1). At Muehlweg, 54% found this information "good". At Utendorfgasse, 55% rated written info "good", 26% the meeting, 48% the on-site explanation. At Roschegasse, 73% found the overall information "good". At Kammelweg-B, 29% rated written info "good", 20% the explanations. At Kammelweg-E, 14% found written material "good", but nobody the explanations (65% rated them "bad"). The internal Dreherstrasse POE asked for heating (59% good) and ventilation information (64% good) separately. At Samer

| Items | MI EHL | UTEN | ROSCBE | KAM-B | KAM-E | DREH | SAMMOE | OFNER | CONTROLS |
|---------------------|---------|---------|-----------|---------|-----------|--------------------|-----------|----------|-------------|
| Location | Vienna | Vienna | Vienna | Vienna | Vienna | Vienna | Salzburg | Salzburg | Vienna/Sbg. |
| District | 21 | 13 | 11 | 21 | 21 | 11 | Gnigl | Itzling | various |
| Buildg. company | BAI | HOE | AH | Mischek | Mischek | BU WO G | HOE | GSWG | various |
| Housing units | 70 | 39 | 114 | 88 | (87)61 | 27 | 60 | 92 | various |
| Evaluated units | 46 | 31 | 45 | 56 | 30 | 17 | 47 | 52 | 156/88 |
| Floors | 5 | 5 | 5 | 7 | 7 | 5 | 3 | 6 | various |
| Floor space | 9,050 | 2,987 | 9,900 | 8,260 | 7,104 | 2,405 | 4,495 | 6,600 | various |
| EE kWh/sqm | 13.1 | 14.5 | 7.3 | 13.0 | 11.0 | 13.0 | | 0 | |
| HLW/sqm | 11.4 | 9.1 | 7.2 | 7.9 | 8.6 | 10.0 | | 9 | |
| Blower door | 0.20/h | 0.18/li | 0.30/h | 0.33/h | 0.28/h | 0.11/h | 0.46/h | 0.32/h | 110 |
| Ventilation | central | central | decentral | central | decentral | central | decentral | central | no |
| Heating* | RH | RH | HP | RH | RH | RH | RH | RH | various |
| Occupied | Nov 06 | Nov 06 | Dec 06 | Oct 07 | Oct 07 | Sep 07 | Sep 06 | Nov 07 | various |
| Evaluated | Apr 07 | May 07 | May 07 | May 08 | May 08 | Apr 08 | May 08 | Dec 08 | 2008/09 |
| Return % | 65.7 | 79.5 | 39.5 | 63.6 | 49.2 | 63.0 | 78.3 | 56.5 | |
| Female return % | 43 | 46 | 64 | 49 | 50 | | 64 | 71 | 48/56 |
| Age mean | 38.4 | 34.5 | 36.3 | 37.3 | 37.6 | | 36.0 | 41.3 | 41.4/49.6 |
| Age range | 19-74 | 20-55 | 21-60 | 23-60 | 22-70 | | 19-61 | 21-82 | 19-88 |
| Household size | 2.2 | 2.4 | 2.7 | 2.5 | 2.1 | | 3.1 | 3.1 | 2.9/2.4 |
| No children % | 75.6 | 41.9 | 48.9 | 56.0 | 73.3 | | 40.0 | 25.0 | 39.5/56.1 |
| Ownership | rented | rented | rented | rented | owner-occ | rented | rented | rented | various |
| Hous.satisf,mean | 1.2 | 1.2 | 1.2 | 1.5 | 2.1 | 1.9 | 1.9 | 1.7 | 2.0/1.8 |
| High li(>us.satisf% | 80.0 | 87.1 | 81.8 | 55.4 | 23.3 | 41.0 | 25.5 | 48.1 | 29.5/44.0 |
| PH-information % | 78.3 | 83.9 | 91.1 | 82.1 | 73.3 | 94 ^a | 34.8 | 40.8 | 34.5/ |
| PH-preference % | 40.0 | 6.9 | 29.5 | 24.1 | 40.0 | 53.0 | | 0.0 | |
| PH-sympathy % | 73.9 | 83.9 | 75.0 | 63.6 | 30.0 | 65 ^a | 39.1 | 50.0 | 67.3/72.9 |
| Tech-Med+ % | 54.3 | 54.8 | 73.3 | 28.6 | 14.3 | 59/64 ^a | 34.0 | 46.8 | |
| Comm.HM+ % | 30.2 | 32.1 | 24.4 | 47.8 | 0.0 | | 28.9 | 16.3 | 37.0/50.0 |
| Heat.problems % | 52 | 50 | 29 | 20 | 47 | 12 ^a | 58 | | |
| Vetir.problems % | | 24 | 25 | 46 | 93 | 3(T | 42 | 20 | |
| Ener.sav.v.imp.% | 89.1 | 64.5 | 91.1 | 82.1 | 83.3 | | 70.2 | 76.5 | 57.0/64.8 |
| PT perman.use % | 32.6 | 32.3 | 35.6 | 51.8 | 43.3 | | | 24.0 | 39.7/18.6 |

Tabela 1: Nepremičnine, stanovalci, podatki o vrednotenju PSH in naprav za upravljanje VPV-1.

Table 1: Properties, occupants, POE-1 evaluation data of PH and controls.

Remarks/abbreviations: EE=Energy index (PHPP), HL=Heating load (PHPP) IG Passive House Database; *OFNER — Building computed in GEO, not PHPP standard; Heating*RH=Reheating, HP=Heat pump; Tech-Med+ = Technology-mediation good, %; Comm.HM+ = Communication with housing management good, %; DREH "- different question formats; Ener. sav.v.imp.%=Energy saving very important, %; PT perman.use %=public transport permanent use, %.

Moesl, 34% rated written info "good", 32% the explanations. 47% gave good marks at Franz-Ofner-Strasse.

Overall, six properties showed average to above-average information evaluations, three were suboptimal. Two of the latter were properties with low housing satisfaction. Although information is not the only relevant factor, it is important for the PH image.

Specific PH lay theories? The POE questionnaires did not collect qualitative data on PH lay theories. During the Muehlweg project, the author heard that in one of the four houses, a rumour spread that the PH would get ice-cold when people went on Xmas vacations, "because PH is only heated by its residents". It took some effort to explain that the PH insulation has a slow cool-off time function, and that small radiators were ready in every apartment. As PH is an unfamiliar technology, lay theories should be assessed and replies given in a FAQ format.

Summary and outlook

A complete POE series of all multistorey PH properties with 577 housing units opened at Vienna and Salzburg in 2006-2007 reached a resident sample of 324 (59% of the occupied apartments) with the same POE questionnaire format. It was found that five of the eight PH projects had higher satisfaction levels than conventional housing. Three reached the mean satisfaction level of Austrian detached housing. PH has established brand quality in several projects, tested by information about PH energy saving, expressed personal sympathy and willingness to recommend PH to friends. PH energy saving as first choice feature was less dominant - most residents named other choice features like location. PH did not show prominent gender or age effects. The weakest detected area was heating and ventilation immediately after moving-in: in three properties, the majority of the residents reported problems and shortcoming that had to be adjusted. Written PH information was rated above average in four properties. Multimodal information (written-presentation-individual on-site) can be developed further. In one documented case, a PH lay theory had to be corrected.

As complex PH technology offers no intuitive understanding, system information and trouble-shooting in case of problems are crucial for the formation of the PH and management image by the residents. In one project (Kammelweg-E), the only owner-occupied PH of the series, a critical communication situation developed and had to be improved with effort.

The POE outlook after eight multistorey PH projects in the mainstream is positive - sustainable housing is a capable solution, but needs multimodal communication to meet the required standards. As successful architects have to offer creative innovations (i.e. singular experimental solutions), a danger of initial defects remains. New PH residents should be informed about a necessary adjustment period of the heating and ventilation system and encouraged to give feedback about system functions. PH should be a "learning system". POE is a powerful tool to check the social dimension of this innovation process, and can also help to identify important user needs for the next design cycle in sustainable housing.

Smutny and Treberspurg evaluated a PH student hostel at Vienna-Molkereistrasse with 278 housing units for international students opened 2005 [Smutny, Treberspurg, Oberhuber, 2008]. At Innsbruck, Tyrol, the Lodenareal property is under construction with 354 rented PH housing units, some already occupied and to be evaluated in 2011. At Vienna-Aspanggruende, the Eurogate

PH complex with 740 housing units is planned. Passive Housing spreads quickly and exponentially - and further POE will be necessary to test and secure the quality standards of this new, sustainable housing form. EC programs already announce zero and plus energy buildings as the next political steps - the social sustainability of solutions will have to be evaluated.

An adapted version of our multistorey PH instrument is being used for the POE of single detached houses in the Vienna area. An English version is available for possible comparison studies with other European housing properties. For the United States, Richard Wener (2010) has expressed interest in the evaluation of low-energy houses. Austrian plans for the future are a simpler ergonomics of the PH operating instruments and increased effort to give PH inhabitants efficient information to cope successfully with their new housing situation.

References *[German titles translated to English]*

- Biermayr, P. et al. (2001): Analysis of supporting and obstructing factors for the market introduction of innovative housing projects [in German]. Vienna, Institute for Energy Economics, Vienna University of Technology.
- Canter, D. V. (1970): Architectural psychology. Proceedings of the Conference held at Dalandhui University of Strathclyde, 28 February - 2 March 1969. London, RIBA.
- Feist, W. (1992): The Passive House [in German]. Heidelberg, C.F. Mueller.
- Flade, A. (1997): Research on innovative housing projects at Hestia: Project Frankfurt-Praunheim [in German]. Darmstadt, Institute for Housing and Environment.
- Furnham, A.F. (1988): Lay theories. Oxford, Pergamon Press.
- Gentner, D., Stevens, A.L. (1983): Mental models. Hillsdale, NJ, Lawrence Erlbaum.
- Guttmann, G., Maderthaner, R. (1974): Housing-psychological study: Terrace estate Graz-St.Peter [in German]. Vienna, Research Association for Building, Planning and Housing.
- Keul, A.G. (2000a): Subjective housing value as a sustainability criterion. POE of energy-saving and conventional housing projects at Salzburg City [in German]. Salzburg, Project report for Building of Tomorrow.
- Keul, A.G. (2000b): Model project Glantreppelweg - The occupants' opinion. POE results [in German]. Salzburg, Project report for the Salzburg Chamber of Labour.
- Keul, A.G. (2010): On the acceptance of the passive house in mass housing - Evaluation (POE) of eight Austrian housing properties and a comparison with conventional residences [in German]. *Umweltpsychologie* [Environmental Psychology], 14, 1: 66-88.
- Kueller, R. (Ed.). (1973): Architectural psychology. Proceedings of the Lund conference, June 26-29, 1973. Lund, Studentlitteratur.
- Kurzmann, G. (2008): User survey on Dreherstrasse PH Object 01201 [in German]. Vienna, Internal BUWOG Cooperative Memo.
- Marans, R.W., Spreckelmeyer, K.F. (1981): Evaluating built environments: A behavioral approach. Ann Arbor, MI, University of Michigan.
- Martens, B., Keul, A.G. (Eds.). (2005): Designing Social Innovation. Planning, Building, Evaluating. Proceedings of IAPS18, Vienna 2004. Goettingen, Hogrefe & Huber.
- McCloskey, M. (1983): Intuitive Physics. *Scientific American*, 24: 122-130.
- Ornetzeder, M., Rohrer, H. (2001): User experiences as a base for sustainable housing concepts [in German]. Vienna, Project report for Building of Tomorrow.
- Passive House Institute (Ed.). (1997): User behavior [in German]. Darmstadt, Passive House Institute.
- Preiser, W.F.E., Rabinowitz, H.Z., White, E.T. (1988): Post-Occupancy Evaluation. New York, Van Nostrand Reinhold.
- Preiser, W.F.E., Vischer, J.C. (Eds.). (2005): Assessing Building Performance. Amsterdam, Elsevier.
- Rogers, E.M. (1995): Diffusion of innovations. New York, Free Press.
- Rohrmann, B. (1994): Social Sciences Evaluation of the Passive house at Darmstadt [in German]. Darmstadt, Institute for Housing and Environment.
- Smutny, R., Treberspurg, M., Oberhuber, A. (2008): Sustainability monitoring of „Molkereistrasse“. POE of user satisfaction, energy performance and climate protection value of the Vienna PH-student hostel „Molkereistrasse“ [in German]. Vienna, University for Agriculture.
- Solomon, M.R. (1996): Consumer Behavior. Upper Saddle River, NJ, Prentice Hall.
- Sommer, R. (1983): Social Design. Creating buildings with people in mind. Englewood Cliffs, NJ, Prentice-Hall.
- Walden, R. (2008): Architectural psychology: Schools, universities and office buildings of the future [in German]. Lengerich, Pabst.
- Wener, R., Andrews, C. (2010): Issues and methods in post occupancy evaluations of green buildings. Contribution to session 2b-2, IAPS21, June 27-July 2, Leipzig, Germany.
- Zimring, C. (2002): Postoccupancy evaluation: Issues and implementation. In A. Churchman & R.B. Bechtel (Eds.), *Handbook of environmental psychology* (pp. 306-319). New York, Wiley.

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