

D.6.7 Certification Criteria for Verified Building Performance

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OUTPHIT – DEEP RETROFITS MADE FASTER, CHEAPER AND MORE RELIABLE

outPHit pairs such approaches with the rigour of Passive House principles to make deep retrofits cost-effective, faster and more reliable. On the basis of case studies across Europe and in collaboration with a wide variety of stakeholders, outPHit is addressing barriers to the uptake of high quality deep retrofits while facilitating the development of high performance renovation systems, tools for decision making and quality assurance safeguards.

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CONTENTS

Introduction.....3
Aim and Scope.....3
Measuring uncertainty of Data4
Availability of Measured Data4
Living Quality5
 Thermal Comfort and air quality5
 Microbiological assessment of indoor air6
Energy performance.....7
 Data Evaluation and performance optimisation7
Process schematic9
Documentation.....10
References.....10

INTRODUCTION

This report presents criteria to be used within the outPHit project in order to comprehensively rate a building's performance in the field.

The method presents a true **building efficiency assessment**, efficiency being defined as the proportion of useful outcome (Living Quality) per effort spent Energy Performance).

It builds on the methods developed to derive a holistic living quality assessment as are documented as the outPHit deliverable D6.11 (*Report on living quality indicators before and after retrofit*). The methodology used to measure and evaluate the energy performance corresponds to the outPHit deliverable D6.5 (*Description of a certification scheme on "verified building performance"*). The respective prerequisites and requirements on measuring uncertainty and implementation of the monitoring apply.

The criteria facilitate a streamlined and largely automated process of building performance evaluation, with sound consideration of measuring uncertainty. It strikes the required balance to adequately rate the Living Quality as the numerator of the efficiency definition, comprising thermal comfort and indoor air quality, the latter indicated in terms of relative humidity and carbon dioxide concentration, supplemented by a spot check on airborne fungal spores. The denominator is represented by the metered energy used to achieve this result, normalised for the prevailing weather conditions and some factors of user behaviour.

AIM AND SCOPE

Aim of the outPHit project's "Verified Performance" programme is to verify the performance of a deep retrofit in the field as a standard measure of final approval. If carried out by an independent party that both customer and supplier have previously agreed upon, the process may offer an unbiased analysis to both.

The Verified Performance certification is applicable to buildings that meet the Passive House Institute's *Passive House*, *EnerPHit* and *Low Energy Building* standards, ascertained by a third party certification of the design. Whether other buildings can be covered must be agreed with the certifier before beginning any work.

MEASURING UNCERTAINTY OF DATA

Measured data for the Verified Performance certification programme must comply with the requirements as stated in the table:

Quantity	Specification
Temperature	± 0.3 K
Relative humidity	± 3 %
Global horizontal irradiation	± 5 % of daily integrals
Air pressure	± 1 hPa
CO ₂ concentration	$\pm (40 \text{ ppm} + 5 \text{ \% of value})$

Table 1: Requirements for max. tolerable measuring uncertainty of sensors

Energy meters (gas, heat, electricity, etc.) must be MID compliant according to the building type/user requirements. For sub-metering devices without official gauging are permissible.

Credible and sufficiently detailed data sheets and other proof of quality must be made available to the certifier's satisfaction.

AVAILABILITY OF MEASURED DATA

Data must be acquired in regular intervals not exceeding 20 minutes and saved with time stamps. A change-of-value (COV) approach with time stamped data only produced in retrospect is not permissible. Failures in data acquisition must not exceed 10% of the total time, with individual outages not exceeding 14 days.

After construction or deep retrofit building operation regularly suffers from ongoing finishing work, initial faults in building services or shading systems, drying effects and the occupants must get used the characteristics of their new home during the first year of operation. As a result the first twelvemonth period of monitoring data is invaluable to *qualitatively* track the building performance, spot any shortcomings and initiate optimisation action. Any required action must have been taken in order to systematically commission the shading and building services systems

and controls and work towards an optimised building operation in line with the design objectives. Only the second year’s data is then relatively undisturbed and useful for *quantitative* assessment.

For Verified Performance certification it is, therefore, required to prove one year of close, at least monthly, qualitative evaluation of the building performance (for example within the PHI’s monitoring platform), a log of deficiencies found, respective remediation action initiated, time of execution and review of the result. The second year of monitoring data is then used for quantitative assessment as detailed below.

LIVING QUALITY

THERMAL COMFORT AND AIR QUALITY

Complete time lines for room temperature, relative humidity and carbon dioxide concentration must be available. For the assessment the data set comprising at 12 consecutive months of hourly mean values is first separated into “summer” and “winter” subsets.

The relative threshold deviation (RTD)¹ is derived for either period and for each parameter in each monitored room.

If any parameter’s RTD for an individual room exceeds 0.1, the cause must be researched and feedback and advice given to the respective users. If building services systems cause the deviation it must be established to the certifier’s satisfaction that appropriate action has been taken to avoid the phenomenon in the future.

No single parameter’s RTD, averaged for the building, must exceed 0.1.
 The sum of all parameter’s RTD, averaged for the building, must not exceed 0.3

	RTD summer	RDT winter
Room temperature	≤ 0.1	≤ 0.1
Relative humidity room air	≤ 0.1	≤ 0.1
Carbon dioxide concentration room air	≤ 0.1	≤ 0.1
total	≤ 0.3	≤ 0.3

Table 2: Requirements for the relative threshold deviation of parameters describing indoor conditions in terms of thermal comfort and indoor air quality

¹ For details refer to the outPHit Report on Living Quality Indicators

MICROBIOLOGICAL ASSESSMENT OF INDOOR AIR

Spot-check samples of airborne fungal spores must be taken in at least 25% of all dwelling units of a building. *ISO 16000-18: Sampling by impaction* is to be observed, using 100l each at 2xMEA and 2xDG18 nutrients, both for the indoor samples and the outdoor reference samples.

All samples and identification analyses of the airborne fungal spores after refurbishment must meet the "indoor source improbable" rating according to the UBA/WHO assessment guide [Seifert 2002], for *genera typical in outdoor air*, *genera untypical in outdoor air* and *species untypical in outdoor air* respectively.

Category	Assessment
Genera typical in outdoor air	Indoor source improbable
Genera untypical in outdoor air	Indoor source improbable
Species untypical in outdoor air	Indoor source improbable

Table 3: Assessment categories and required assessment per UBA guidelines on airborne fungal spores

Any ranking of "Indoor source cannot be ruled out" requires another round of sampling, to rule out random effects, and must result in appropriate action depending on the result.

ENERGY PERFORMANCE

DATA EVALUATION

The quantitative evaluation via the PHPP energy balance model, performed automatically within the PHI's monitoring platform, shall find the metered energy in line with the calculated plausibility limits for all months. Any deviations require a plausible explanation to the satisfaction of the certifier.

The area-specific, annual space heating demand must not differ by more than a certain allowance ΔQ from the expected value. This allowance depends on the number of zones or dwellings in the building, designated n :

$$\Delta Q = 3 \frac{\text{kWh}}{\text{m}^2\text{a}} + 3 \cdot \frac{1}{\sqrt{n}}$$

Formula 1: Derives the permissible deviation of expected and metered area-specific annual space heating demand

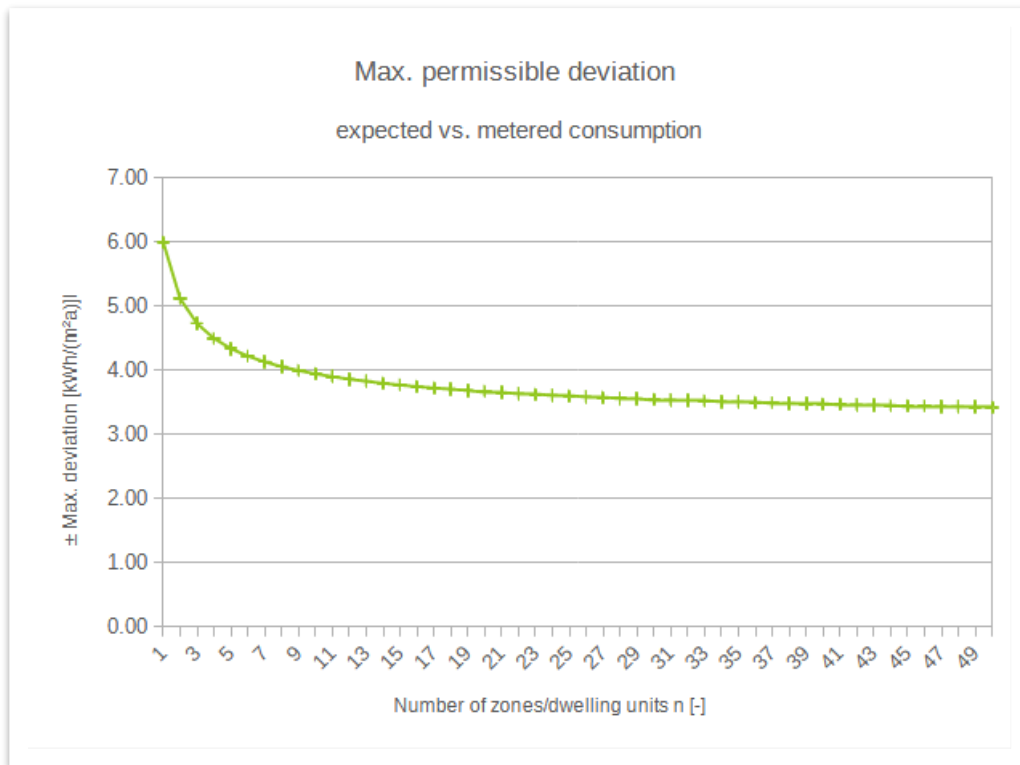


Fig. 1: Plot of formula 1 in the interval 1-50 units

Even with great care the input data to any energy balance calculation are subject to uncertainties of dimensions, material properties etc. As a result even in an ideal

case the calculation results have a $\pm 3 \text{ kWh}/(\text{m}^2\text{a})$ uncertainty range². For the monitoring evaluation the influences of weather, indoor temperature and internal heat gains are explicitly considered, but other factors, mainly in the field of user behaviour, are not precisely known. For a house ($n=1$) the user behaviour has the largest impact, while for growing n the effects of different preferences increasingly tend to cancel each other out. The extra allowance of $3 \text{ kWh}/(\text{m}^2\text{a})$ at $n=1$ approximately corresponds to the effect of a permanently tilted bedroom window during the winter.

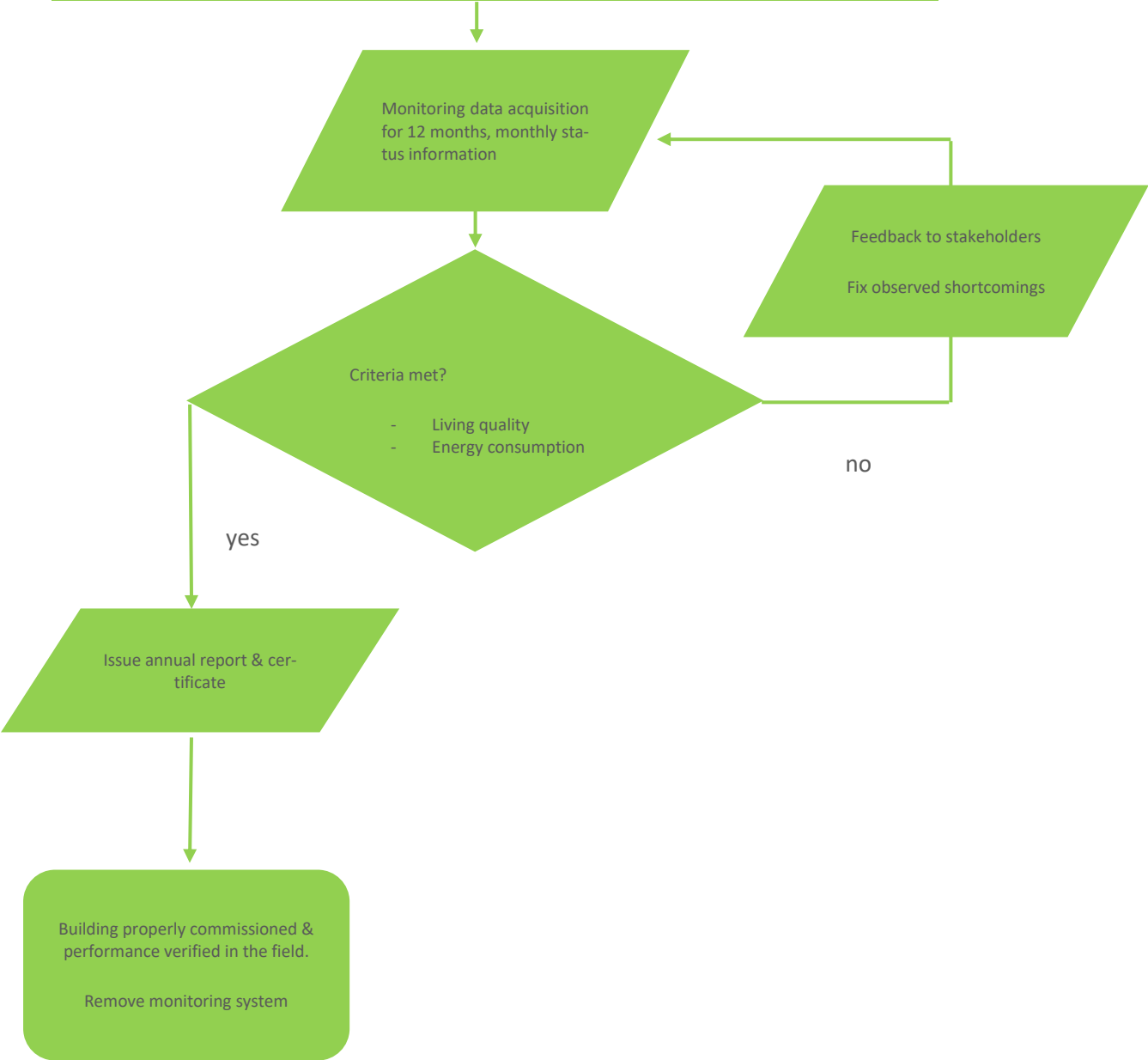
With regard to a three-year average of metered energy consumption before retrofit or the PHPP result for the unrefurbished condition of the building, performed for the prevailing weather conditions, taking into account a partial-heating factor, the expected reduction in space heating demand must be met within $\pm 10\%$.

If household electricity consumption exceeds $20 \text{ kWh}/(\text{m}^2\text{a})$ for any zone or dwelling unit, feedback to the respective building users shall be given, including guidance on efficient use of electricity. Appropriate documentation of the action is made available to the certifier.

² For details refer to the outPHit Verified Performance Concept

PROCESS SCHEMATIC

- Prerequisites:
- A careful energy efficiency design with third-party QA (e.g. [PHPP10])
 - careful site supervision
 - Prefabrication for improved quality
 - Qualified experts and tradespersons
 - Airtightness verified for pressurisation and depressurisation
 - Systematic commissioning of MVHR
 - Energy balance calculation (e.g. with[PHPP10] adjusted to reflect any alterations on site)
 - With the completion of the renovation project, a third-party verification (e.g. a building certification according to the EnerPHit standard) confirms the fulfilment of the criteria of the efficiency standard



DOCUMENTATION

The monitoring platform generates a standardised report skeleton, that documents the central evaluation results, based on the measured values, the living quality verdict and energy use assessment with regard to the certification criteria.

If consent is given, the evaluation results are also displayed as part of the publicly accessible on-line documentation of the outPHit case study projects at

www.outphit.eu .

REFERENCES

[Seifert 2002] Seifert, B. e.a.: Leitfaden zur Vorbeugung, Untersuchung, Bewertung und Sanierung von Schimmelpilzwachstum in Innenräumen, [Umweltbundesamt](#), Berlin 2002.

[outPHit Verified Performance Concept](#)

[outPHit Simplified Monitoring Approach](#)

[outPHit Instructions for adequate monitoring equipment for living quality assessment](#)

[outPHit Report on Living Quality Indicators](#)