April 17, 2023

A Review of the report *Grid Benefits of Passive Houses, Phase II*

A Passive House Network Report

The Passive House Network

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The following is a review of the report *Grid Benefits of Passive Houses, Phase II*, produced by Opinion Dynamics (OD) for the California Public Utilities Commission (CPUC), dated December 20, 2022. A draft copy of this report was provided to Bronwyn Barry, The Passive House Network's (PHN) Policy Lead, for review, input and feedback. PHN subsequently engaged Passive House Institute (PHI) Certifier, Steve Mann, to run a limited analysis of the Opinion Dynamics findings, focused primarily on validating the PHI results.

Executive Summary

This PHN study attempted to replicate the results posted in the Opinion Dynamics (OD) report. As PHN's request to access the OD EnergyPlus models was declined, we elected to replicate OD's results by using the Passive House Planning Package (PHPP) to compare current Title 24, Part 6 energy code requirements and Passive House Institute (PHI) Classic certification. PHN's review was limited to the single family one story model to determine whether further analysis of all three model buildings was necessary.

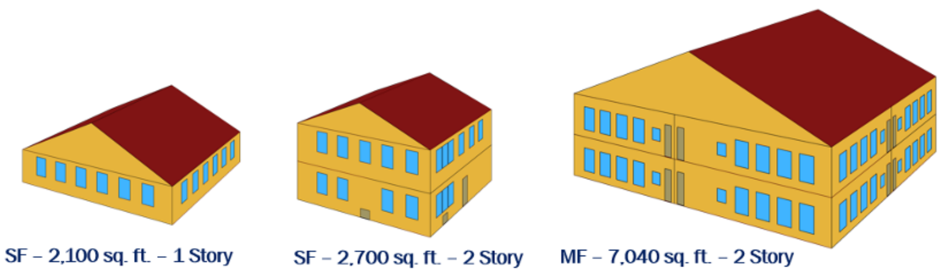
The results obtained by PHN in this report diverge significantly from the Opinion Dynamics results and findings for their PHI models. This leads us to conclude that the draft report by OD requires significant re-writing and re-calculation of all PHI results.

Methodology

The focus of this review was to confirm and verify PHI performance results in comparison with California's energy code. The Passive House Planning Package (PHPP) software was selected to verify the input assumptions outlined in OD's report because it is the energy model required for PHI certification. (Both Passive House certification standards require a specific model to verify performance results.) PHPP has been validated by third party reviewers in accordance with ASHRAE 140 protocols (Charron, 2019).) Additionally, over 2,000 Passive House buildings were surveyed in 2020 to confirm that the PHPP predictive modeling results aligned well with their measured outcomes. (No other physics-based, energy modeling software packages, including EnergyPlus, are credentialed to validate performance results for Passive House certification. The Passive House Planning Package (PHPP) is a customized software package that has been fine-tuned over 35 years of project-related experience and is now accepted for code compliance calculations in jurisdictions from Massachusetts to Washington State. The EnergyPlus files used by Opinion Dynamics were not made available to PHN for this review, further confirming our choice.

The basis of comparison was limited to PHI and Title 24, Part 6 (T24) and used the 2019 version of the CEC's T24 Energy code in alignment with the OD study. The analysis was further limited to the SFH-1 model to determine whether additional review of all models was necessary. It is noted that although the OD report indicates it was using the CF-1 prototype as documented in the *2019 ACM Approval Model*, the OD report image (Fig. 9) shows a slightly different prototype. In order to keep results as closely in alignment as possible to the OD analysis, this analysis used the prototype shown in the OD report.

Figure 1. Opinion Dynamics Figure 9. Building Simulation Model Prototype Images



This analysis does not provide a review or analysis of Phius results as presented in the OD report. This report is solely focused on validating the OD results for the PHI standards, and to support Opinion Dynamics in providing accurate and professionally verified results to the CPUC. PHN encourages OD to reach out to Phius for their input prior to publishing findings.

1. Defining Passive House Standards

Firstly, as a point of clarification, both Passive House certification entities (PHI and Phius) operating in North America offer multiple certifications. It is unclear which Passive House standards were used in the OD draft analysis as they are not identified. For the purposes of this review, this analysis utilized the 'PHI Classic' standard as the PHN baseline comparison standard. All current Passive House certifications are listed below in *Table 1*.

Table 1. Overview of various certification options.

Current Passive House Standards

PHI (PHPPv.10)	Low Energy Building	New Construction - All bldg types
	Classic*	
	Plus	
	Premium	
	EnerPHit - Classic	Retrofits - all bldg types
	EnerPHit - Plus	
	EnerPHit - Premium	
Phius (2021)	Phius+ 2021 Performance Path	New + Retrofit
	Core Prescriptive for SFH's	New SFH's
	Core REVIVE	Retrofit
	Zero	

* 'Classic' is considered the baseline PHI 'Passive House' building. PHN used this standard for our study.

The above *Table 1* lists the various Passive House certifications currently available to practitioners working in North America. For new construction projects, PHI offers performance pathway certification options exclusively, with 'Classic' certification being their lowest baseline option. Please note that in addition to Passive House certification, PHI offers a 'Low Energy Building' certification for projects which fail to meet their Classic criteria. However, this certification is generally not considered a 'Passive House' certification, which is why Classic certification criteria were selected as the baseline for PHN's comparison.

In addition to the baseline 'Classic' Certification, the 'Plus' and 'Premium' certifications available from PHI offer improved performance targets. These higher tiered certification levels recognize both increased efficiency and increased onsite generation, based on direct benefits to a future 100% renewable-energy grid. It is significant that neither of these PHI certifications were mentioned or considered in the OD report. PHN recommends that these be considered, particularly for remote regions, and climates where higher efficiency and greater on site generation could offer benefit to owners and utilities.

Given the existence of multiple Passive House certification options, it would be helpful if Opinion Dynamics:

- [ ] Identifies the specific Passive House standards used in its analysis,
- [ ] Recognizes the higher tier certification pathways, and
- [ ] Ensures that the whole-building performance pathways are not conflated with prescriptive options.

2. Input Assumption Anomalies

For reasons stated in the methodology, PHPP was selected to verify the input assumptions outlined in OD's *Table 8. Housing Type Performance Parameters.* By electing to use PHPP in lieu of EnergyPlus, we were able to avoid multiple 'lost in translation' issues that have proven problematic in previous comparative assessments between PHI's standards and the CEC's Title 24, Part 6 energy code.[1]

As a result, the inputs necessary to meet PHI standards differed in all three climate zones from those used by Opinion Dynamics in their report and are highlighted below in yellow. We include PHN results on the left and OD results on the right side for easy comparison.

Table 2. Revised inputs for SF - 2,100 sf - 1 Story house model showing all 3 Climate Zones.

PHN's Housing Type Performance Parameters using PHPP			OD's Housing Type Performance Parameters using E+		
	T24	PHI	T24	PHI	Phius
CZ 04- San Jose			CZ 04- San Jose		
Wall Insulation	R21+ R5 - 2x6 walls	R21+ R5 - 2x6 walls	R21+ R5 - 2x6 walls	R21+ R5 - 2x6 walls	R22+ R5 - 2x6 walls
Roof Insulation	R30	R30	R30	R30	R56
Slab Insulation	None	R5	None	None	R21 Perimeter
Glazing U-value	0.3	0.3	0.3	0.3	0.3
Glazing SHGC	0.23	0.47	0.23	0.23	0.23
Ventilation	Exhaust only	Min. heat recovery rate: 75%	Exhaust only	Energy Recovery Ventilator - 70% Eff.	Energy Recovery Ventilator - 70% Eff.
Infiltration	5 ACH50	0.6 ACH50	5 ACH50	0.6 ACH50	0.6 ACH50

[1] *These anomalies were listed in the footnotes of the Reach Code Study conducted by Franklin Energy 2019 for the CASE Cost Effectiveness Low Rise Multifamily Passive House Equivalency and made more visible in a subsequent Passive House California posting* [here.](#)

CZ 07- San Diego		
Wall Insulation	R15+ R5 - 2x4 walls	R15+ R5 - 2x4 walls
Roof Insulation	R30	R30
Slab Insulation	None	None
Glazing U-value	0.3	0.3
Glazing SHGC	0.23	0.3
Ventilation	Exhaust only	Min. heat recovery rate: 75%
Infiltration	5 ACH50	0.6 ACH50
CZ 14- Palmdale		
Wall Insulation	R21+ R5 - 2x6 walls	R21+ R5 - 2x6 walls
Roof Insulation	R38	R38
Slab Insulation	None	None
Glazing U-value	0.3	0.3
Glazing SHGC	0.23	0.23
Ventilation	Exhaust only	Min. heat recovery rate: 75%
Infiltration	5 ACH50	0.6 ACH50

CZ 07- San Diego		
R15+ R5 - 2x4 walls	R15+ R5 - 2x4 walls	R20+ R5 - 2x6 walls
R30	R30	R53
None	None	R21 Perimeter
0.3	0.3	0.3
0.23	0.23	0.23
Exhaust only	Energy Recovery Ventilator - 70% Eff.	Energy Recovery Ventilator - 70% Eff.
5 ACH50	0.6 ACH50	0.6 ACH50
CZ 14- Palmdale		
R21+ R5 - 2x6 walls	R21+ R5 - 2x6 walls	R22+ R5 - 2x6 walls
R38	R38	R60
None	None	R21 Perimeter
0.3	0.3	0.24
0.23	0.23	0.23
Exhaust only	Energy Recovery Ventilator - 70% Eff.	Energy Recovery Ventilator - 70% Eff.
5 ACH50	0.6 ACH50	0.6 ACH50

Notes/Assumptions

- PHPP uses Treated Floor Area (TFA) which has been assumed to be 85% of Conditioned Floor Area (CFA.)
- The Title 24 models are based on prescriptive req's for each climate zone. The PHI models use the same prescriptive values and only changed heat recovery, infiltration and SHGC, plus slab insulation in CZ04
- Differences between each pair of calculations was minimized to reduce the number of variables affecting the results.
- Both T24 & PHI buildings assumed minimally-efficient 9 HSPF/8.5 EER on/off heat pumps for all climates. Heat pump sizes were determined by the largest heating/cooling loads for each building.
- Typical Passive House buildings would have >75% recovery efficiency HRVs and more efficient, variable-speed heat pumps.
- Typical Passive House calculations would include thermal bridge calculations which would further improve the PHI scores.

3. Impact on Results

The results obtained in this PHN analysis diverge significantly from the Opinion Dynamics findings of PHI results. The results are summarized in Table 3 below:

Table 3. PHPP results for SF-1 model compared to OD SF-1 draft report results.

PHN's SF-1 Annual Whole-House Savings Comparison by House Type

		Energy use per kWh		% Reduction	HVAC Energy use (kWh & % of Total)		% Reduction
Home Type	CZ	T24	PHI	PHN	T24	PHI	PHN
SF-1	CZ07	5,364	4,864	9%	3,053	2,553	16%
	CZ04	8,210	6,201	24%	5,899	3,890	34%
	CZ14	9,882	5,125	48%	7,570	2,814	**63%**

OD's SF-1 Annual Whole-House Savings Comparison by House Type

		Energy use per kWh		% Reduction	HVAC Energy use (kWh & % of Total)		% Reduction
Home Type	CZ	T24	PHI	OD	T24	PHI	OD
SF-1	CZ07	5,774	5,823	-0.8%	608	657	-8.1%
	CZ04	6,067	6,018	0.8%	899	850	5.4%
	CZ14	7,401	7,101	4.1%	2,265	1,966	13.2%

When using PHPP, PHN's results show significant improvement in all three climate zones over California's 2019 Title 24, Part 6 baseline code for the SF-1 model. These results differ significantly from the EnergyPlus results generated by OD in their draft report.

4. Why the discrepancies?

Variations in the PHN results compared to the Opinion Dynamics results may be ascribed to the following:

1. It is clear that OD's PHI modeling input assumptions identified in Table 2 (OD's Table 8) are incorrect. Based on the analysis, it is likely that there are other errors, which cannot be identified without access to the EnergyPlus models.

2. A strong possibility for the substantial divergence may be **a difference in how area inputs are calculated in EnergyPlus compared to those used in PHPP**, which will skew results. Without copies of the OD originated model files, it is impossible to validate the OD conclusions.
3. PHPP uses an interior usable area calculation known as Treated Floor Area (TFA), which excludes exterior walls, interior walls, and some interior spaces from the total square footage, thus creating a smaller area over which all 'per square foot' targets must be met.

   EnergyPlus typically uses a standard Conditioned Floor Area (CFA) calculation, which is measured to the exterior insulation surface and includes all interior walls. Without making an adjustment for this software modeling difference, PHI results will appear less rigorous when calculated in EnergyPlus. To assist OD in providing more accurate modeling of PHI's standards in EnergyPlus, *Table 4* below identifies the average differences between treated floor area (TFA) and conditioned floor area (CFA) for three single family home projects located in California (including the two used in Phase I of OD's study,) plus the impact that using CFA in place of TFA has on their predicted energy use outcomes.

Table 4. PHPP difference between Treated Floor Area (TFA) & Conditioned Floor Area (CFA) for 3 Californian PHI projects.

Project Name	House type	CFA (SF)	TFA (SF)	CFA - TFA: % Difference	PHPP Primary Energy kBtu/(ft²a)	Total PE (using TFA) (kBtu/a)	Total PE (using CFA) (kBtu/a)	Increase in Total PE Calc. ERROR (%)
Sunnyvale I	SFH - 1 story	1,677	1,506	89.8%	36.44	54,861.88	61,109.88	111%
Sunnyvale II	SFH - 1 story	1,542	1,371	88.9%	23.8	32,600.04	36,669.61	112%
Alamo	SFH - 2 story	3,050	2,573	84.4%	23.8	61,198.54	72,518.79	118%

4. PHN's technical community conveyed additional challenges encountered when using EnergyPlus to simulate PHI results. These 'lost in translation' anomalies exist due to structural and assumption modeling differences between the two software models. These include differing inputs required for external shading elements, window frame and installation detailing, and energy/heat-recovery ventilation unit calculations and inputs[2] amongst others, which generate differing outcomes. The significant differences in predicted HVAC energy use shows further divergence in the two software programs. PHN's reviewers shared that this has previously been ascribed to differences in internal heat gain assumptions.

[2] A 2016 review of ventilation strategies across European countries compared to the USA "concluded that the maximum ventilation flows are similar but the control procedures are very different." (Guillén-Lambea et al.)

5. Further Discussion

PHN found it gratifying to confirm the close correlation between almost all of the PHI Classic and T24 prescriptive assembly requirements. This may be viewed as both a compliment to the rigor of the California Energy Commission's current code, plus a confirmation that most of the assemblies required for PHI's Classic standard are already cost optimized for all three climate zones. However, the notable divergence between T24 and PHI's requirements for envelope air infiltration/exfiltration, glazing SHGC, and ventilation energy/heat recovery efficiency indicate that these particular benefits have not yet been adequately explored, or may be insufficiently calibrated in conventionally used compliance software packages. Given that the PHPP was used by both Passive House projects analyzed by OD in Phase I of this study, we note that OD has already confirmed that PHI's Classic standard delivers significant benefits to California's grid.

The key question this raises is: *if three relatively small improvements to the baseline code deliver such significantly beneficial results to California's grid, why have they not been more robustly considered and mandated?* This small window of divergence between T24 and PHI requirements may provide the key to the greatest Californian grid benefits for the least amount of cost increase.

6. Missed Opportunities

While PHN's review was limited to the single family one-story home results, we believe that similar anomalies in results may be reliably extrapolated to all three building types.

It must be noted that there are additional items that were neither discussed nor covered in the OD report, which merit disclosure. These include:

- ☐ **PHI's Primary Energy Renewables (PER) framework:** This framework delivers a climate-specific standard for PHI. PER works within the PHPP and generates climate-specific utilization factors that differ for all climates, rather than a 'one size fits all' electrical utilization factor. From the utility sector perspective, this is of key importance. It is the driver behind the climate-specific load shaving evidenced in the monitoring data captured by OD in their Phase I report[3] (and offers an explanation for why the summer peak load reduction was more significant than the winter peak for the two Passive House projects.) The PER framework is designed to deliver a more stable seasonal load shape for utilities and offers reliably accurate load predictions to the residential building design sector.

[3] Passive House as a Grid Resource. ACEEE Summer Study, 2022. https://aceee2022.conferencespot.org/event-data/pdf/catalyst_activity_32610/catalyst_activity_paper_20220810191639356_eee5e703_cea0_4aa3_8454_3e92c950ae91

- [ ] **Climate Specific:** Please note that OD repeats a misperception around 'climate-specific' targets which includes the presumption that PHI's standards are not climate specific. While PHI's front-end targets do not change, the factors used to calculate total energy use do differ by location and climate. These are all calculated internally within PHPP and mean that the PHPP generates climate-specific outcomes uniquely designed to support a fully renewable energy grid. It thereby generates climate-specific outcomes for all projects. PHI's standard is therefore 'climate specific.'
- [ ] **Open source code:** It should be noted that the PHPP's Excel format is transparent and adaptable. Custom dashboards, plug-ins and scripts may be easily generated for this modeling tool. Indeed, a customizable PER tab is already available for customization by any utility, city, state or region decision-maker.
- [ ] **Future code ready:** As States move towards adoption of Building Energy Performance Standards (BEPS) the impact of upfront material's embodied carbon, and the need to calculate embodied carbon, has become more urgent. PHN already supports this evolution and funded the development of a US-specific plugin for PHPP called PHribbon[4]. This enables the simultaneous calculation of embodied carbon and operational energy within the same model.

7. Summary Findings and Conclusions

Because the Opinion Dynamics draft report findings for PHI's certification differ so notably from the results shared here, PHN cannot support or endorse its publication as-is. PHN recommends that OD rerun their models using, as closely as possible, the same parameters as shown in our Table 2 and using adjustments that account for TFA vs CFA differences. Without access to the EnergyPlus originated model files, OD's findings cannot be validated and therefore should not be considered for use by the CPUC or any entity in public policy. Any model used by OD in support of its conclusions, must be made available to the public for review. PHN will make our PHPP models available to anyone with a valid license.

In support of the recommendations and findings detailed herein, we respectfully recommend that the CPUC review the 2022 ACEEE Summer Study paper, titled *'Policy Onramps: Using Passive House to Accelerate Building Decarbonization.' (Barry, PHN)* This paper aptly identifies the barriers to integration of Passive House into baseline code, while simultaneously highlighting where Passive House adoption is accelerating **due in no small measure to Passive House being supported as an alternate compliance pathway.** We excerpt this paper below:

[4] https://naphnetwork.org/phribbon/

Baseline Code & Passive House Intersection: An Apples and Oranges Story

During the course of reviewing the spectrum of policies driving Passive House across the continent, we identified a few places where Passive House had been inserted into local baseline code. This prompted us to review how that was working to further understand whether this was worth replicating elsewhere.

In the United States, the baseline energy code uses either ASHRAE's 90.1 energy standard or the International Energy Conservation Code (IECC), with some states and local jurisdictions managing their own energy codes (e.g. California's Title 24, Part 6). These baseline energy codes are structured similarly with prescriptive and performance path options to demonstrate compliance. We dug further into how standard codes were structured against how the Passive House Standard is structured, to find possible opportunities to synthesize or harmonize them. PHN cursory analysis revealed the following major differences:

1. Differing end goals and target markets: *Baseline energy codes have evolved to provide a minimum bar for energy efficiency, while Passive House was designed for optimized delivery of 'hygiene ventilation' using building performance. These are vastly divergent end goals (compliance vs optimized design) aimed at two very different demographics.*

2. Differing structures: *Energy codes advance in 3-5 year cycles, using publicly vetted stakeholder workshops often focused on specific building elements and products. Proposed improvements are required to meet cost-effectiveness criteria in order to be adopted. Passive House standards are defined by the Passive House Institute and administered via a global network of qualified certifiers. They are voluntary building standards advanced via a cooperatively owned and operated international entity.*

3. Different energy models: *Model codes historically use U.S.-developed, open-source, whole building energy simulation programs such as EnergyPlus and EnergyPro. For updates to be adopted, 'cost-effectiveness' must be determined. These are often calculated using NREL's BEOpt software package, with EnergyPlus as its calculation engine. Passive House certification requires the use of either PHI's Passive House Planning Package (PHPP) or Fraunhofer's WufiPassive. In 2014 an NREL-funded study by German, Saddiqui, and Daikin indicated that BEOpt predictions may be insufficiently calibrated to accurately predict the performance of Passive House buildings. Conversely, the Passive House Planning Package (PHPP) provided more accurate predictions when compared to monitored outcomes. Similar challenges were found in another study conducted by the same team for California's Codes and Standards. California's CBEC-Res energy model (built on EnergyPro engine) was unable to capture multiple benefits typically accounted for in PHPP. (Frontier Energy, Misti Bruceri & Associates, 2019). These suggest that studies comparing Passive House performance to standard baseline code buildings should not rely solely on standard modeling engines because they are unable to fully capture their benefits.*

The major discrepancies uncovered in this report perfectly demonstrate why PHN strongly supports all efforts to allow both Passive House models to become accepted as alternate compliance pathways in California.

Thank you for this opportunity to submit this review.

The Passive House Network

Credits and acknowledgements:

Lead author:	Bronwyn Barry, RA, CPHD, PHN Policy Director
Lead analyst:	Steve Mann, MS, CEA, CPHD, PHI Certifier, PHN Technical Lead
Reviewers:	Ken Levenson - PHN Executive Director Craig Stevenson - Auros Group - PHN Board Chair Lois Arena - Steven Winter Associates - PHI Certifier Ed May, CPHC (Phius), CPHD (PHI) - Bldg Type - PHN Trainer Passive House California - Board of Directors Chris Ballard, CEO - Passive House Canada | Maison Passive Canada Jessica Grove-Smith - Passive House Institute

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Remi Charron, Charron Consulting - *PHPP ASHRAE 140 Validation*, 2019. https://passivehousecal.org/wp-content/uploads/2021/05/phpp_ashrae-140-validation-report.pdf

Frontier Energy: *California Codes and Standards Report: 2019 Cost-effectiveness Study: Low-Rise Multifamily Residential New Construction Addendum – Passive House Equivalency Analysis for 2019* Energy Efficiency Ordinances. https://passivehousecal.org/case-passive-house-low-rise-multifamily-reach-code-delivers-results/

Silvia Guillén-Lambea, Beatriz Rodríguez-Soria, José M. Marín - *Review of European ventilation strategies to meet the cooling and heating demands of nearly zero energy buildings (nZEB)/Passivhaus. Comparison with the USA.* Renewable and Sustainable Energy Reviews, Volume 62, September 2016, Pages 561-574. https://www.sciencedirect.com/science/article/abs/pii/S1364032116301319

David Johnston, Mark Siddall, Oliver Ottinger, Soeren Peper & Wolfgang Feist - *Are the energy savings of the passive house standard reliable? A review of the as-built thermal and space heating performance of passive house dwellings from 1990 to 2018*. https://link.springer.com/article/10.1007/s12053-020-09855-7

Resources

1. To assist with confirming PHPP results, we note that a Honeybee to PHPP conversion tool is available here: https://ph-tools.github.io/honeybee_grasshopper_ph/. This allows consultants to push Rhino models to both PHPP and WufiPassive to confirm compliance.
2. Codes for States where Passive House is already adopted as an alternate compliance pathway: https://naphnetwork.org/codes/

Calculating Treated Floor Area

The Treated Floor Area (TFA) is basically the living space or useful area. It is thus a measure of the utilization of the building. For residential buildings, the calculation is based on the guidelines laid out in the living space ordinance [WoflV]; for nonresidential buildings it is based on DIN 277.

Calculation of the Treated Floor Area takes place according to the tables below. Fundamentally, only those areas that are within the thermal envelope are included. The areas are weighted differently (100% or 60%), depending on the use of the rooms. This is done in order to encourage efficient use of high quality spaces inside the thermal envelope and to take into account the various internal heat gains.

Residential buildings

<table>
<tr><td colspan="3">Only surface areas of rooms within the thermal envelope are included in the TFA.

The surface area may be ascertained from the unfinished dimensions of the building.

The following can be taken into account for the surface area:

* Floor-to-ceiling window reveals with a depth of more than 0.13 m (5 ⅛”)

* Plinth, skirting boards, built-in furniture, bathtubs

* Areas under staircases (depending on the height, see below)

* Stair heads and landings</td></tr>
<tr><td>Taken into account with 100%</td><td>Taken into account with 60 %</td><td>Taken into account with 0%</td></tr>
<tr><td>* Living areas where long periods of time are spent,

i.e. window area > 10 % of the surface area, but not behind light shafts)

* Bath/Washrooms

* Auxiliary rooms (areas such as installation rooms, storage rooms etc.) within dwellings

* Access areas within dwellings</td><td>* Auxiliary rooms outside of dwellings or in basements*

* Access areas outside of dwellings or in basements*

* In detached houses auxiliary rooms and access areas are taken into account with 60 % if they are located on floors in which less than 50 % of the floor area consists of living areas, e.g. in the basement</td><td>* Flights of stairs with more than 3 steps

* Elevator shafts Shafts/chimneys > 0.1 m²

* Pillars/room-high facework > 0.1 m²

* Air spaces

* door and floor-to-ceiling window recesses (depth up to 0.13 m (5 ⅛”))

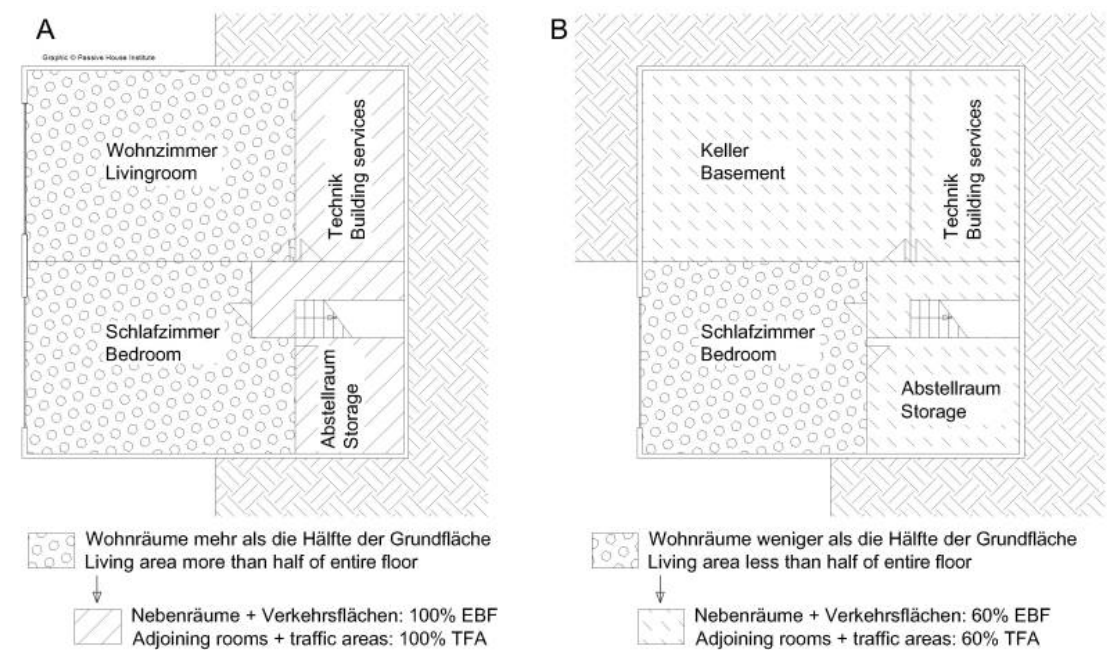
* rooms outside of the thermal envelope</td></tr>
</table>

The following applies for all rooms/partial areas:

Clear height 1 to 2 m ⇒ the TFA is reduced by 50%

(e.g. auxiliary room (h = 1.9 m) outside of the dwelling: half of 60 %, that is 30 %, is taken into account for the TFA)

Clear height less than 1 m ⇒ not taken into account



Example: Auxiliary rooms/access areas in detached houses

If Passive Houses are being built in climate zones other than cool moderate climate zones, then evaluation of the living quality of living areas may differ.

Non-residential buildings

<table>
<tr><td colspan="3">Only surface areas of rooms within the thermal envelope are included in the TFA.

The surface area may be ascertained from the unfinished dimensions of the building.

The following can be taken into account for the surface area:

* Floor-to-ceiling window reveals with a depth of more than 0.13 m (5 ⅛")

* Plinth, skirting boards, built-in furniture, bathtubs

* Areas under staircases (depending on the height, see below)

* Stairheads and landings</td></tr>
<tr><td>Taken into account with 100%</td><td>Taken into account with 60 %</td><td>Taken into account with 0%</td></tr>
<tr><td>Useful areas:

* living areas, offices

* washrooms

* recreational areas

* classrooms, common rooms

* storage rooms

* cloak rooms

* kitchens

* laboratory

* swimming pools + poolside areas

* access and transit areas with additional uses (except emergency exits)</td><td>Technical functional areas:

* house installations room

* plant room for electrical system, ventilation technology, heating, cooling, telecommunications

Access areas:

* corridors (in open plan offices or similar: use at least escape route width)

* foyers

* stair heads and landings</td><td>* flights of stairs with more than 3 steps

* elevator shafts

* installation shafts

* air spaces

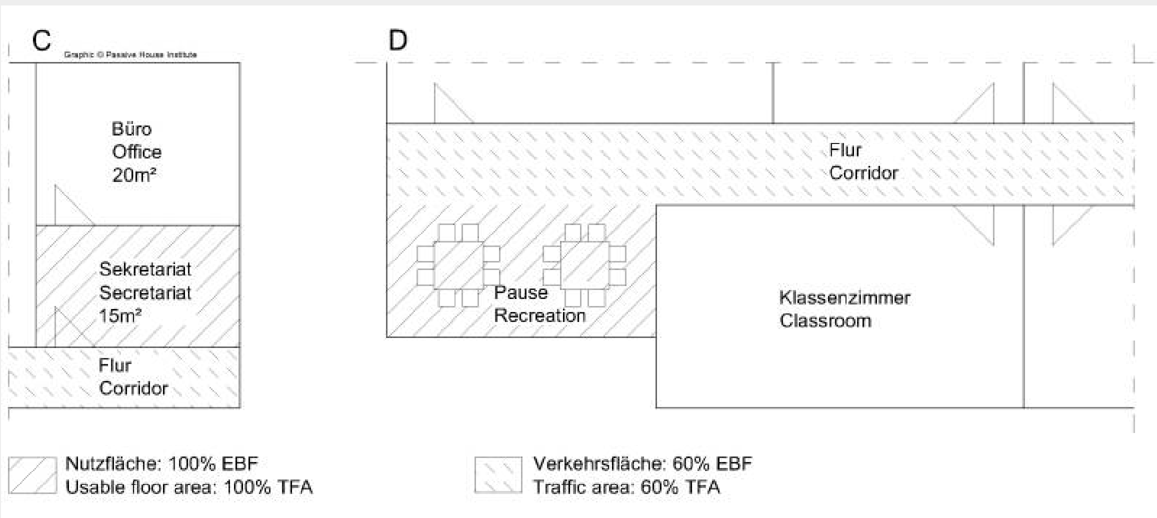
* door and floor-to-ceiling window recesses (depth up to 0.13 m (5 ⅛"))

* rooms outside of the thermal envelope</td></tr>
</table>

The following applies for all rooms/partial areas: Clear height 1 to 2 m ⇒ the TFA is reduced by 50% (e.g. plant room: 30 % is taken into account for the TFA) Clear height less than 1 m ⇒ not taken into account

The consideration of these rooms and areas, including those with shared uses, will be decided by the main use. It is possible that in some cases different areas in a room are calculated in a different way, as can be observed in the following example:

E



Example: Auxiliary rooms/access areas in non-residential buildings

The above information was excerpted directly from Passipedia:
https://passipedia.org/planning/calculating_energy_efficiency/energy_balances_-_background/calculating_the_treated_floor_area