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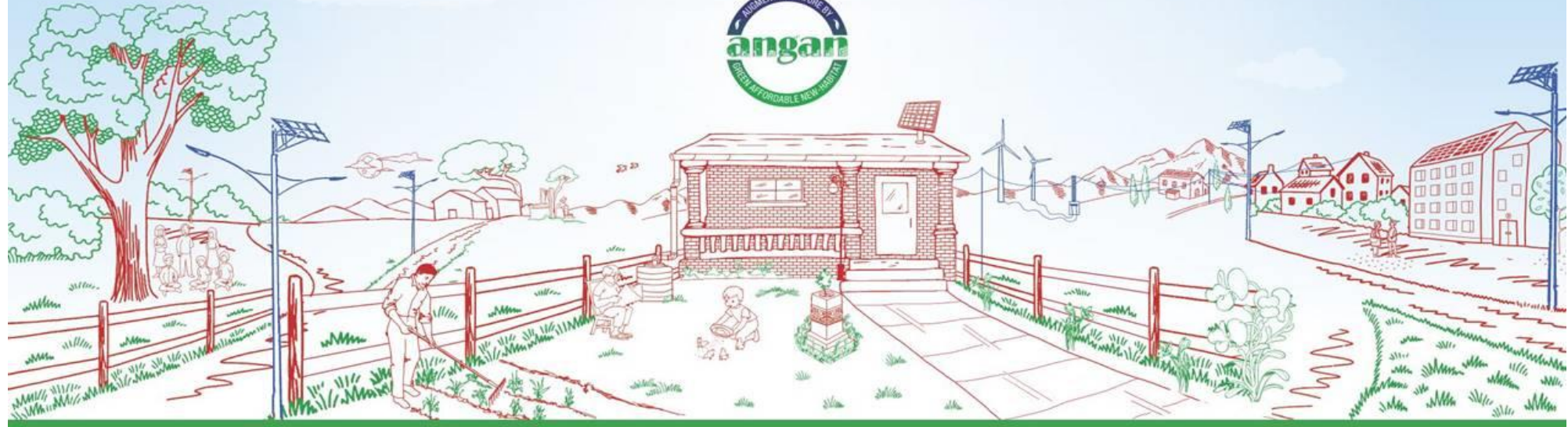
# ANGAN

## Augmenting Nature by Green Affordable New-habitat

A Courtyard for Revolutionary Change in Building Energy Efficiency

An International Conference on Building Energy Efficiency

9<sup>th</sup>-11<sup>th</sup> September, 2019 | Hotel The LaLiT, New Delhi





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THIS PRESENTATION WAS SHARED BY

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FOR THE SESSION:

*“Analytical Tools to Estimate Building Performance”*

DURING ANGAN 2019

Knowledge Partner

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# **Simplified yet reliable energy performance modeling**

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*ANGAN conference, Delhi  
10th September 2019*

# The purpose of energy modeling

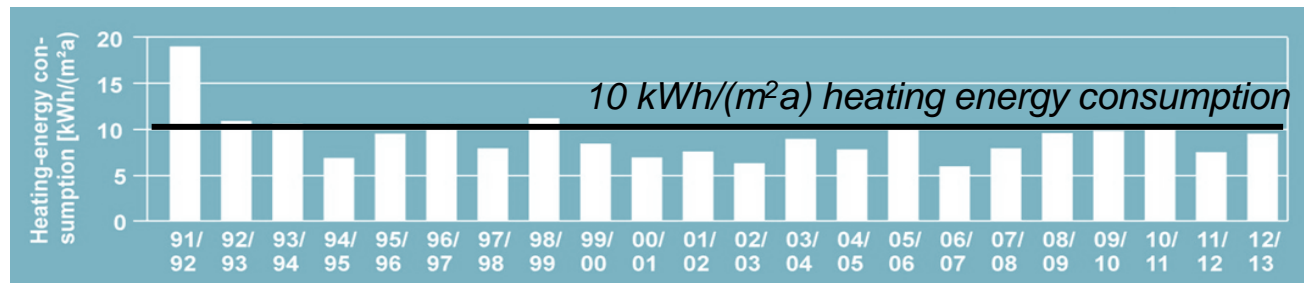
**Effective & reliable design guidance for better buildings.**

- Healthy and comfortable conditions inside buildings.
- Actual real operational energy savings.



Photo: Peter Cook

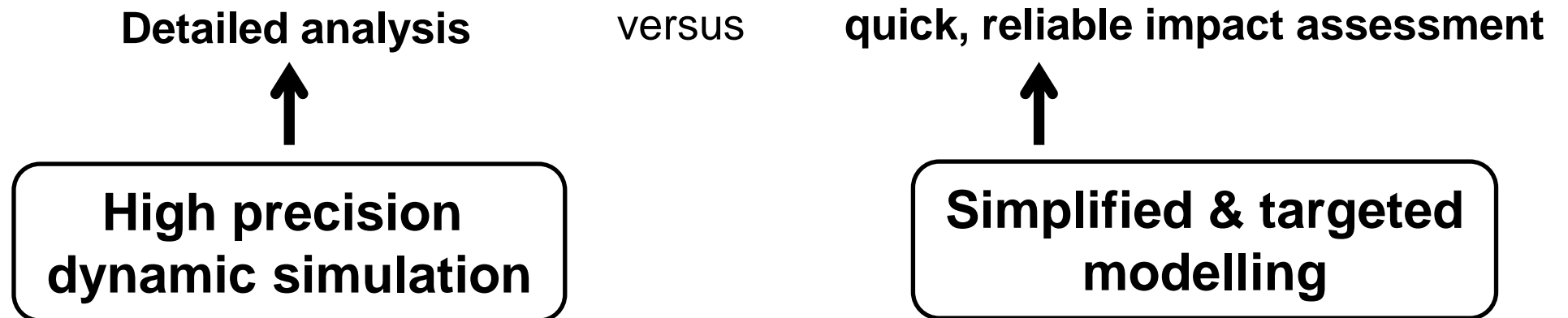
*The first Passive House building, 1991 (Darmstadt, Germany)  
Very high energy performance monitored for more than 25 years!*



# Approaches for accurate energy modeling

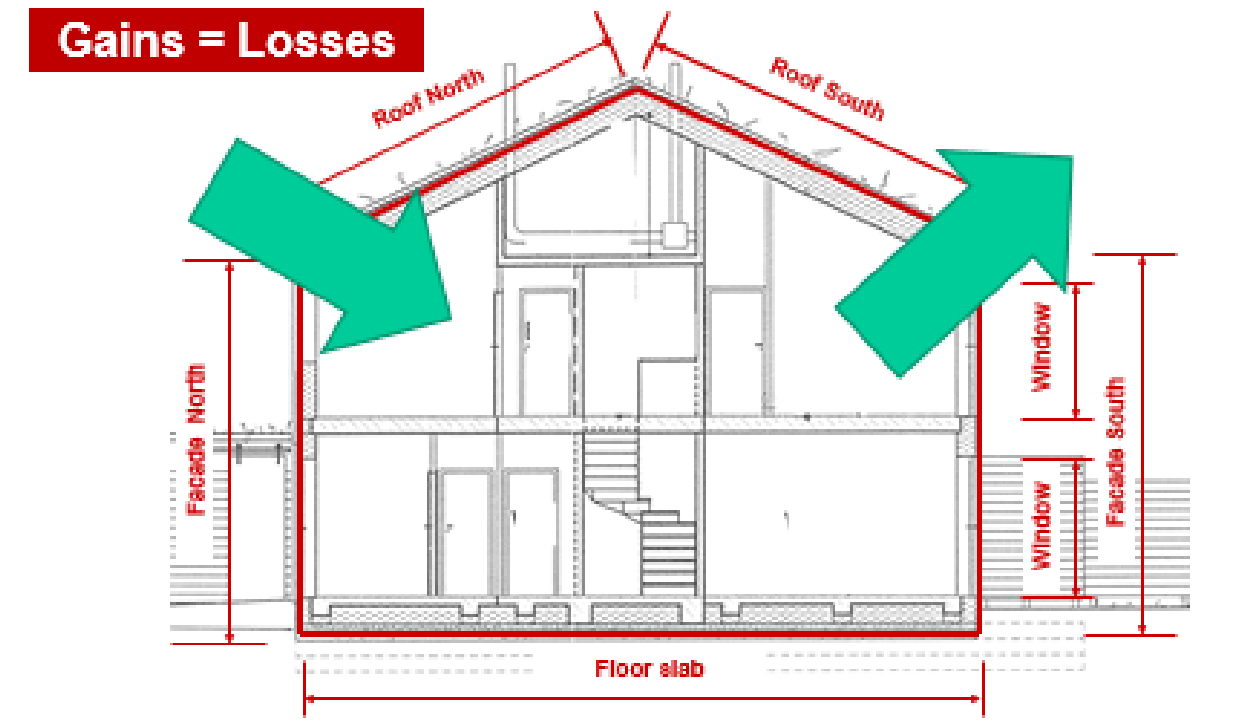
It is ultimately pure physics → not a problem.

The challenge lies in practical use as part of design processes.



# Simplified & targeted modeling for high performance buildings

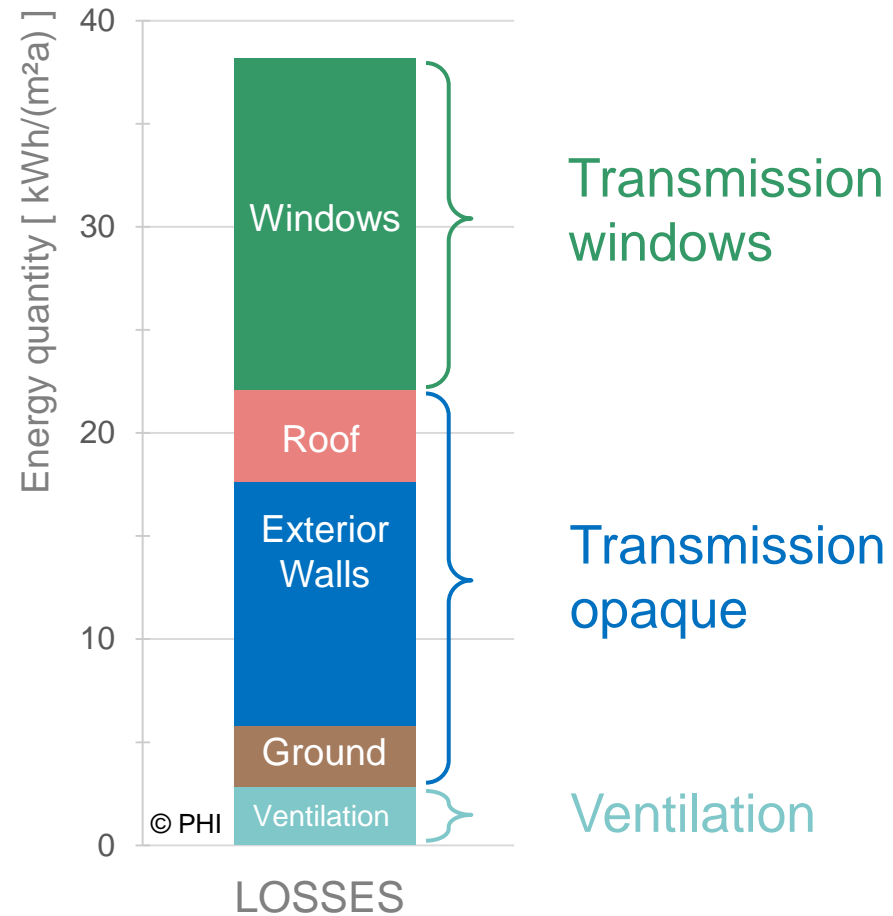
A proven approach: Monthly stationary energy balance.



# Energy Balance – Heating example

Law of energy conservation  
 $\sum \text{heat losses} = \sum \text{heat gains}$

Energy balance  
according to EN ISO 13790

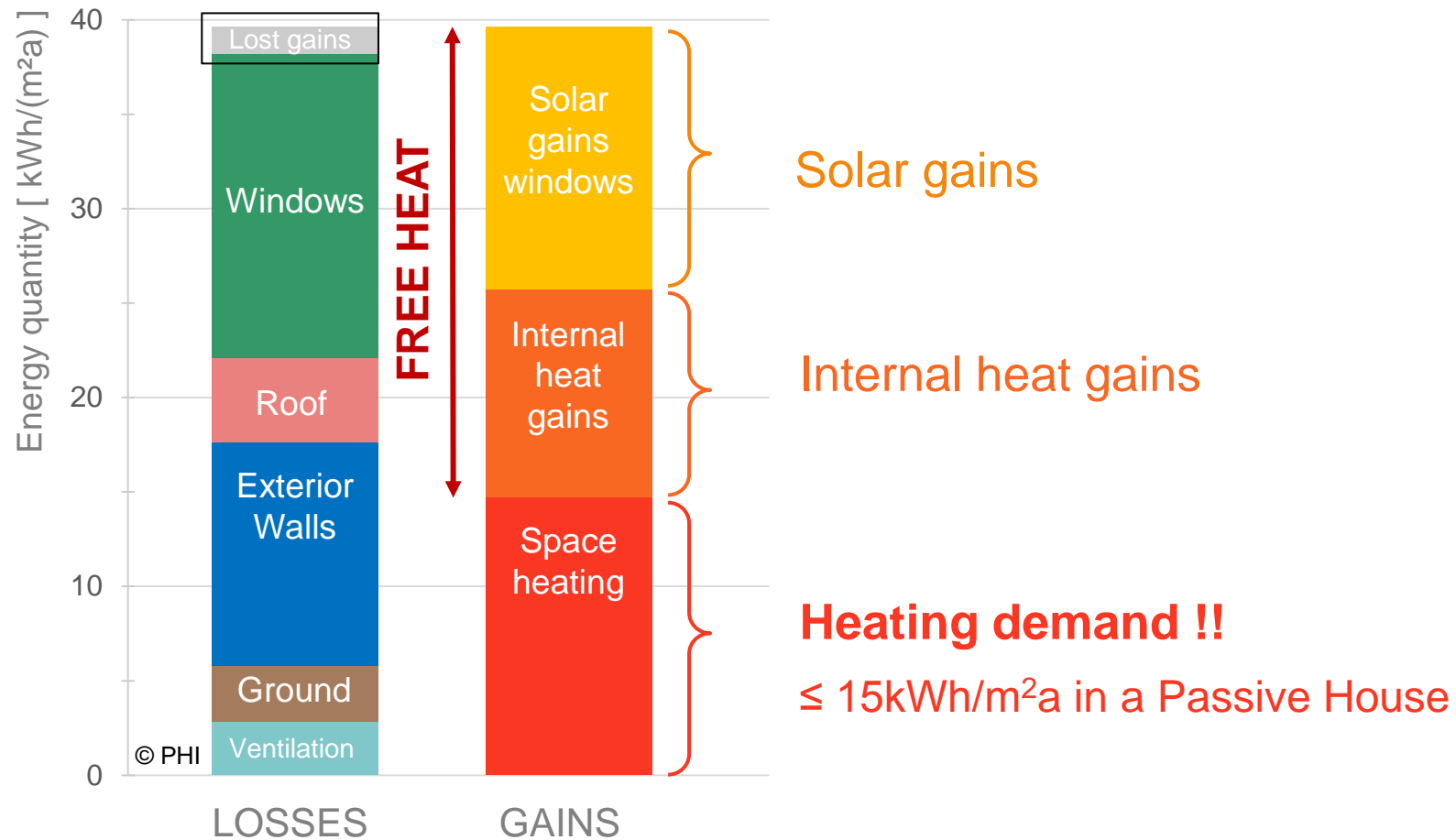


# Energy Balance – Heating example

Law of energy conservation  
 $\sum \text{heat losses} = \sum \text{heat gains}$

Energy balance  
 according to EN ISO 13790

Heat gains which cannot be utilised  
 → simplified approach to account for dynamic effects

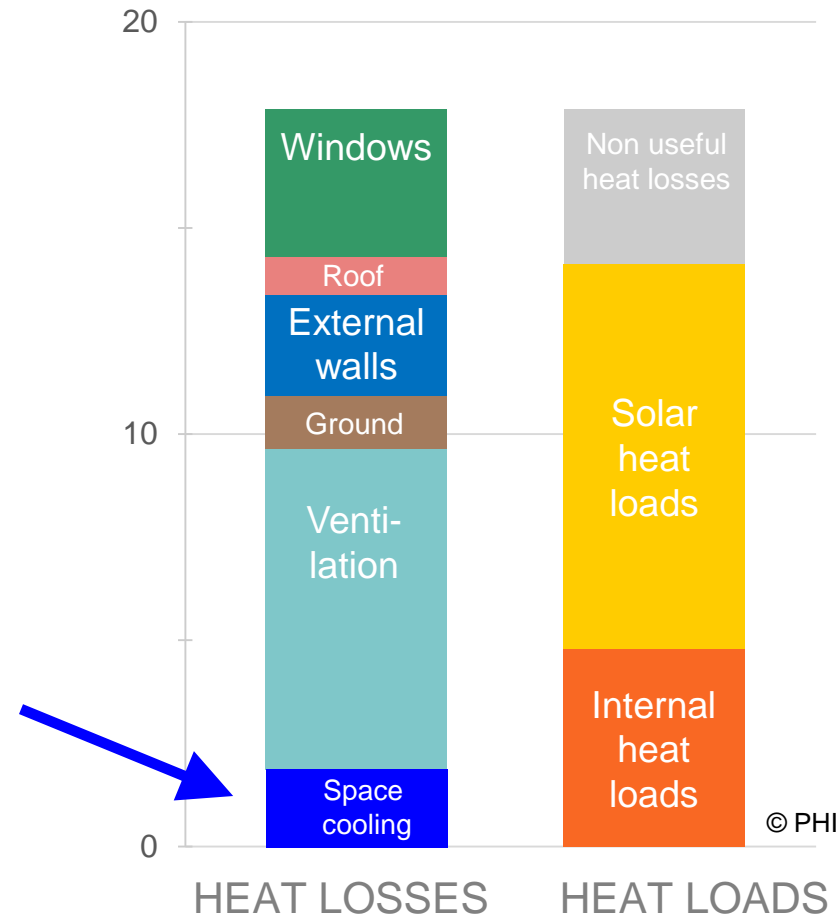


# Energy Balance – Cooling example

Law of energy conservation  
 $\sum \text{heat losses} = \sum \text{heat gains}$

Energy balance  
according to EN ISO 13790

**Cooling demand**  
 $\leq 15\text{kWh/m}^2\text{a}$  in a Passive House\*  
(+ climate allowance)



# The Energy Balance Tool “PHPP”

PHPP = Passive House Planning Package

- ❖ Monthly energy balance for cooling and for heating
- ❖ Excel based:  
Instantaneous results & transparent algorithms
- ❖ Continuous development & long-term experience specifically for highly energy efficient buildings
- ❖ High level of accuracy:
  - (a) Comparison with dynamic simulations
  - (b) Validation based in measured performance



The energy balance and design tool  
for efficient buildings and retrofits



### Passive House Verification

**Building:** End-of-terrace Passive House  
 Street: Example Street 99  
 Postcode/City: 99999 Example City  
 Province/Country: Example Province DE-Germany  
 Building type: Row house  
 Climate data set: KR0003a-Cheongju  
 Climate zone: 3: Cool-temperate Altitude of location: 62 m

**Home owner / Client:** Passivhaus Association of Owners  
 Street: Example Street 99  
 Postcode/City: 99999 Example City  
 Province/Country: Example Province DE-Germany

**Architecture:** Example Architectural Firm  
 Street: Example Street 99  
 Postcode/City: 99999 Example City  
 Province/Country: Example Province DE-Germany

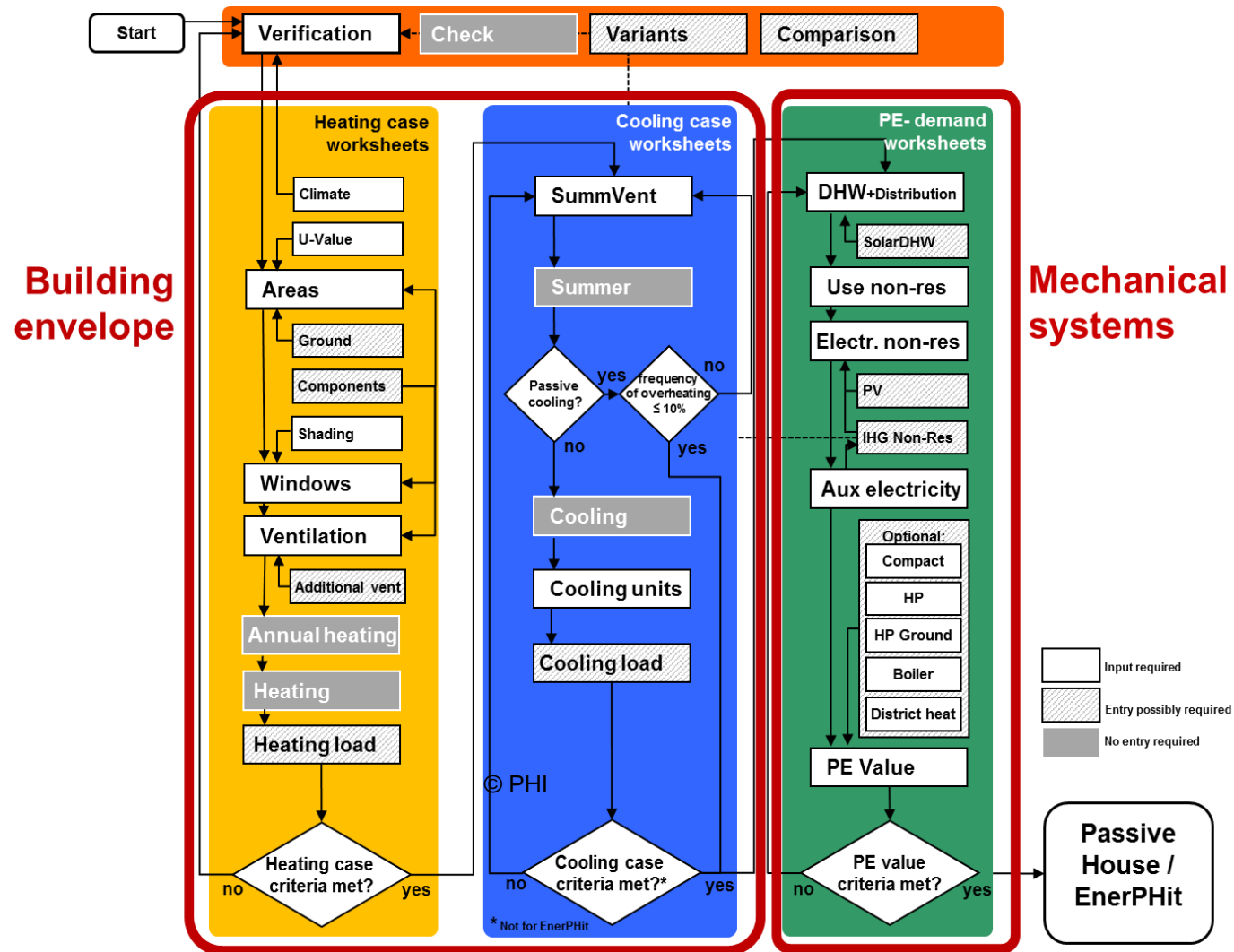
**Mechanical system:** Example Mechanical Services Firm  
 Street: Example Street 99  
 Postcode/City: 99999 Example City  
 Province/Country: Example Province DE-Germany

**Energy consultancy:** Example Energy Consultant  
 Street: Example Street 99  
 Postcode/City: 99999 Example City  
 Province/Country: Example Province DE-Germany

**Certification:** Passive House Institute  
 Street: Rheinstr. 44/46  
 Postcode/City: 64289 Darmstadt  
 Province/Country: DE-Germany

Year of construction: 2015 Interior temperature winter [°C]: 20,0 Interior temp. summer [°C]: 25,0  
 No. of dwelling units: 1 Internal heat gains (IHG) heating case [W/m²]: 2,4 IHG cooling case [W/m²]: 2,4  
 No. of occupants: 2,9 Specific capacity [Wh/K per m² TFA]: 204 Mechanical cooling:

Specific building characteristics with reference to the treated floor area					
	Treated floor area m²		Criteria	Alternative criteria	Fulfilled?²
<b>Space heating</b>	Heating demand kWh/(m²a)	3	≤ 15	-	yes
	Heating load W/m²	5	≤ -	10	yes
<b>Space cooling</b>	Cooling & dehum. demand kWh/(m²a)	-	≤ -	-	-
	Cooling load W/m²	-	≤ -	-	-
	Frequency of overheating (> 25 °C) %	33	≤ 10	-	no
	Frequency excessively high humidity (> 12 g/kg) %	29	≤ 20	-	no
<b>Airtightness</b>	Pressurization test result n <sub>50</sub> 1/h	0,2	≤ 0,6	-	yes
<b>Non-renewable Primary Energy (PE)</b>	PE demand kWh/(m²a)	34	≤ -	-	-
<b>Primary Energy Renewable (PER)</b>	PER demand kWh/(m²a)	21	≤ 60	60	yes
	Generation of renewable energy kWh/(m²a)	170	≥ -	-	yes



## Modelling output:

- Space heating & heating load
- Cooling (latent + sensible) & cooling loads  
OR frequency of overheating (if no active cooling)
- Hot water heating
- Electricity:  
Lighting, appliances, plug loads etc.

reflects performance  
of the building  
under selected climate conditions

total primary energy target  
incl. assumptions on  
occupant choices

- Residential & non-residential buildings
- Newbuild & retrofit projects
- Default occupant choices or project specific assumptions
- Variant calculations and comparisons

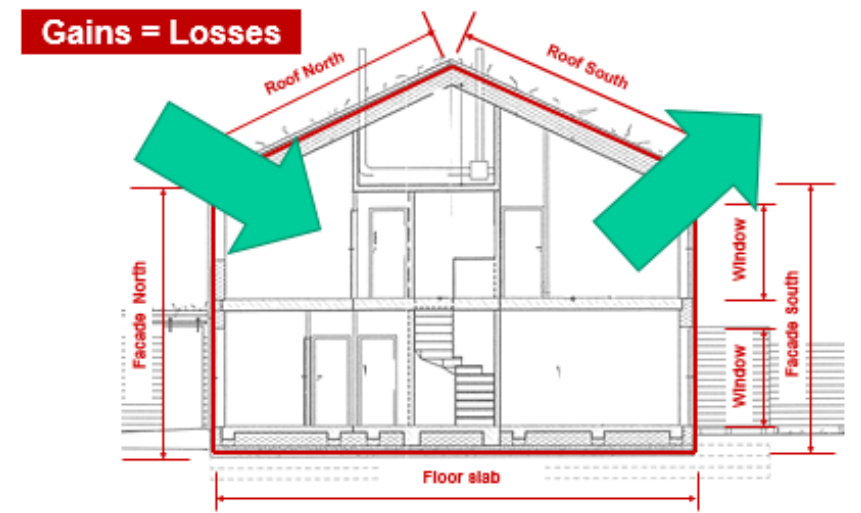
# PHPP as design tool

## OUTPUT:

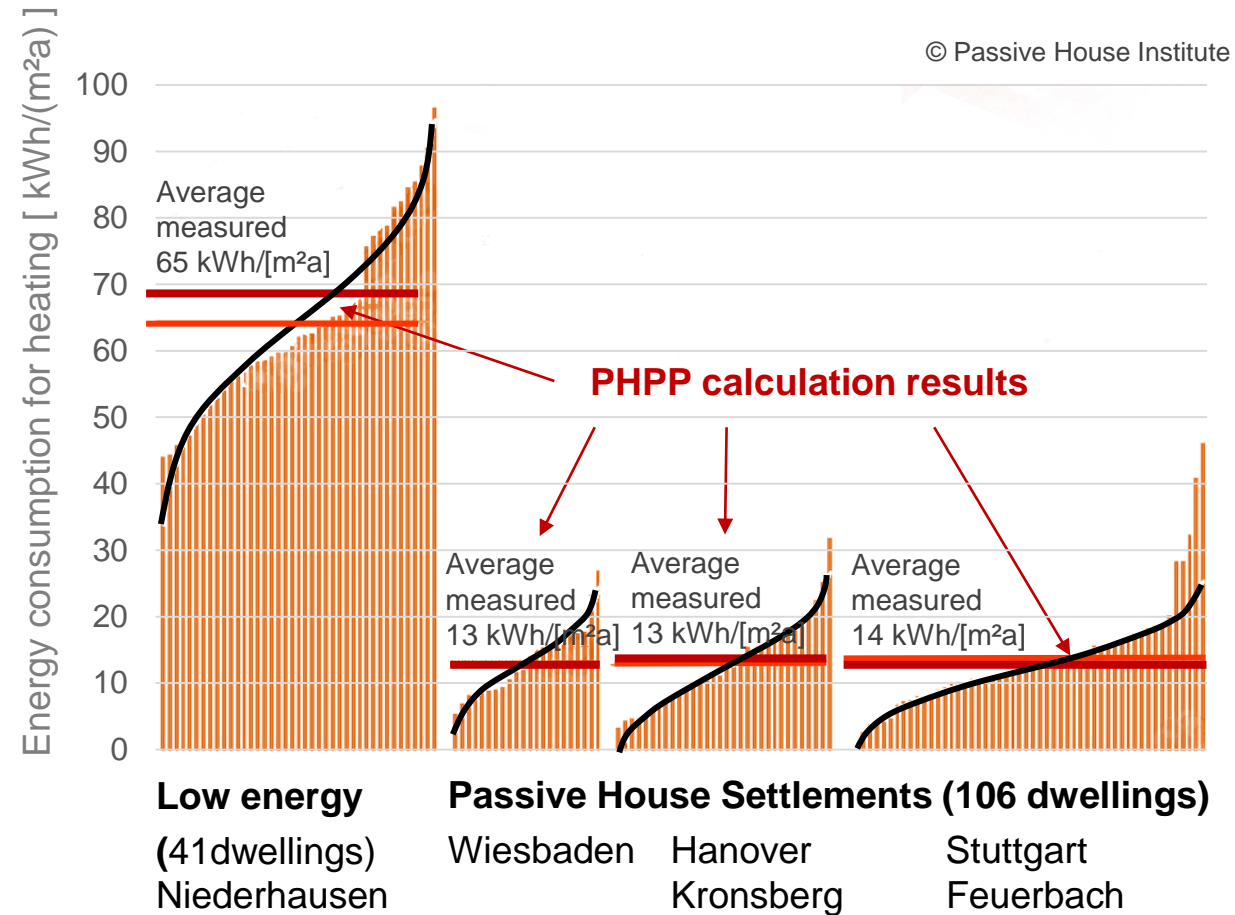
Actual expected energy performance  
(versus relative savings).

## INPUT:

Focus on the relevant influencing parameters  
and necessary level of detail.



# Calculation versus measured consumption: Heating



# Calculation versus measured consumption: Cooling

## Mohammed Bin Rashid Space Centre, Dubai – Passive House office building

very good insulation  
 airtight construction  
 chiller  
 fan coils  
 separate dehumidification of supply air



Monitoring 2017/2018	PHPP original	PHPP with real boundary conditions	measured
Useful cooling & dh [kWh/(m <sup>2</sup> a)]	50	97	104
Primary energy [kWh/(m <sup>2</sup> a)]	143	293	267

*Indoor temp °C:* 25 °C → 22.5  
*IHG W/m<sup>2</sup>:* 2.8 → 6.8  
*Electricity MWh:* 11.6 → 24.9  
*Weather:* (minor adjustments)

# Calculation versus measured consumption: Cooling



Photos: Miwa Mori

## Single family Passive House in Ibaraki, Japan

24.7 °C  
8.9 g/kg

### Total useful cooling energy [kWh/(m<sup>2</sup>a)]

PHPP*	Measured
20	21

\*adjusted:

- measured indoor temp and rh
- internal humidity load (2.3 g/(m<sup>2</sup>h))  
such as to match measured winter humidity

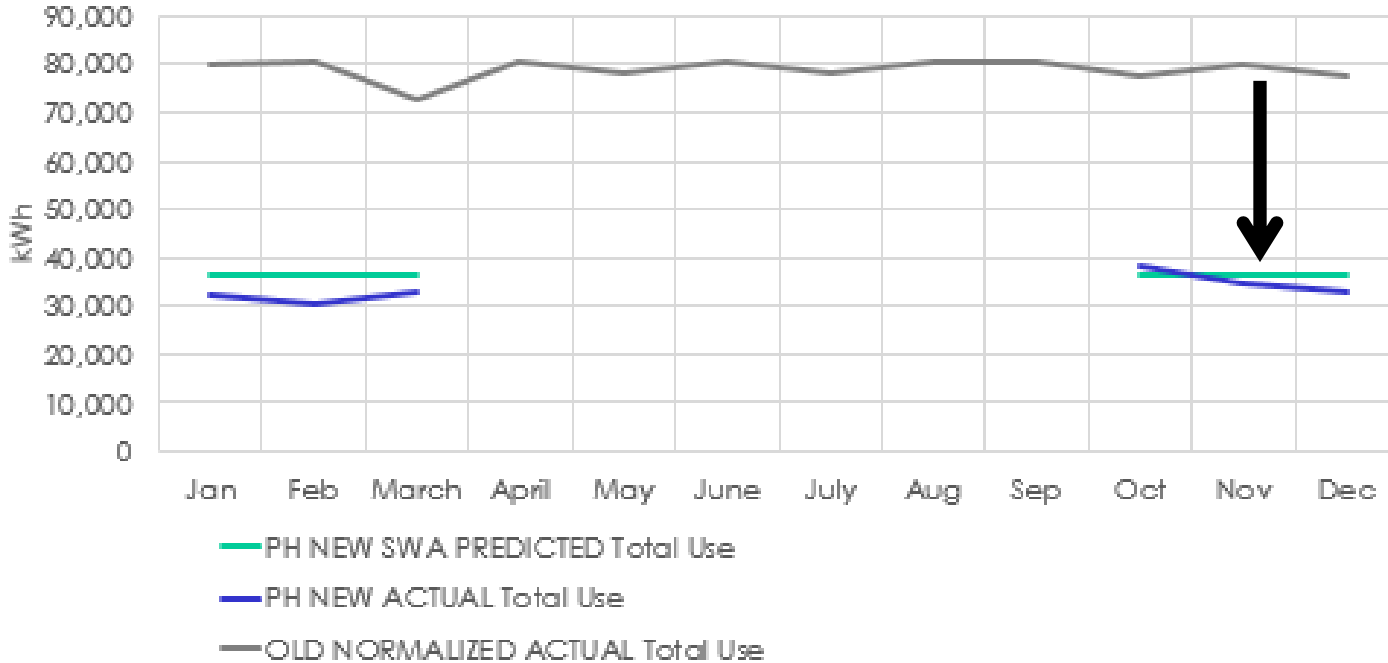
### Supply air cooling

- SEER ≈ 5
- good dehumidification performance
- equal temperatures
- PHPP agrees with measurements
- users are satisfied

# Calculation versus measured consumption: Cooling

## Retrofit EnerPHit project in Kaynayake, Sri Lanka

Light industrial EnerPHit in Sri Lanka - Monthly Energy Usage



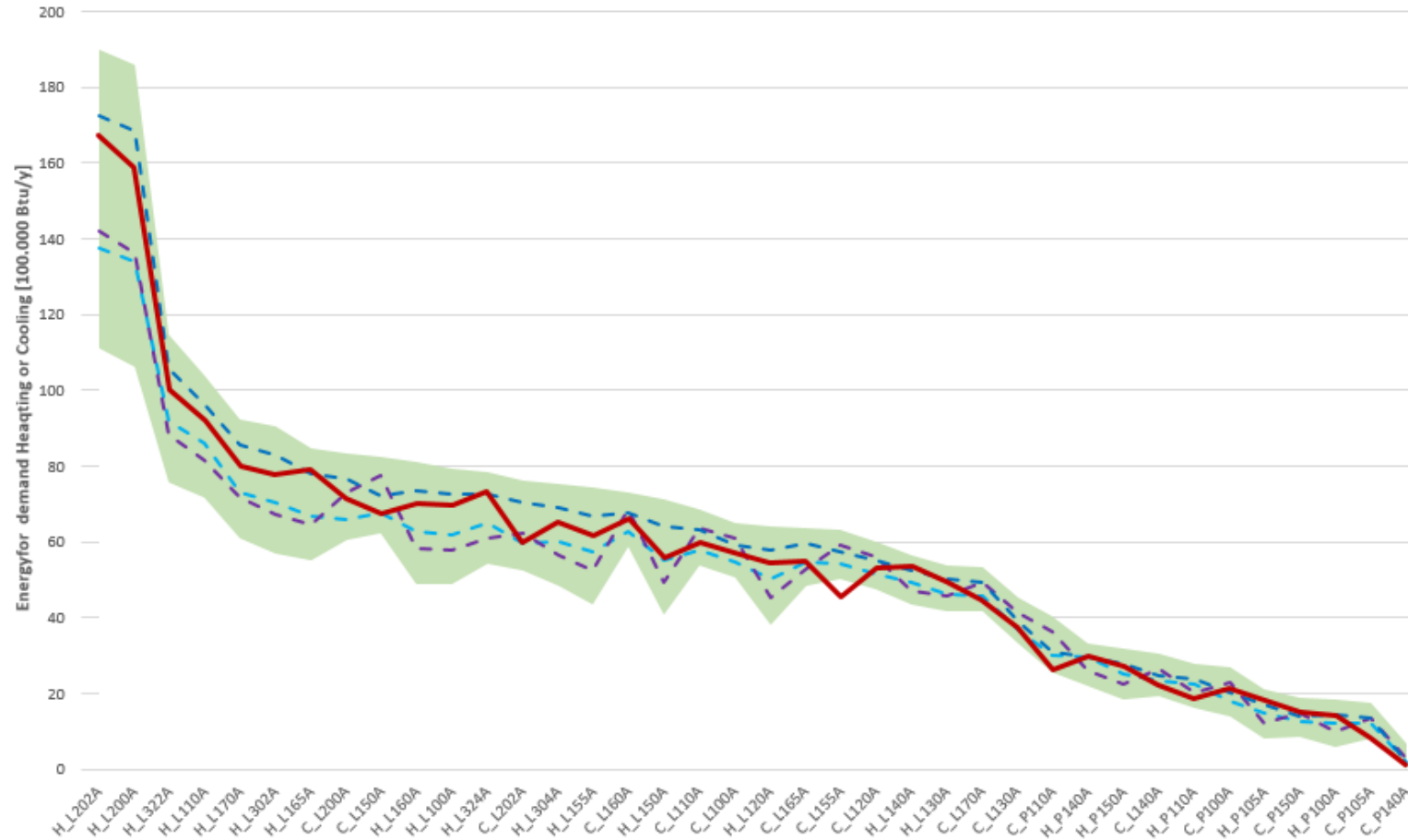
**52% monthly average energy savings**



Photo credit: Ganidu Balasuriya via V2COM

Courtesy of Steven Winter Associates, Passive House Consultant

# PHPP test according to ANSI/ASHRAE Standard 140-2017



**NYPH** NEW YORK PASSIVE HOUSE



PASSIVEHOUSE CANADA MAISONPASSIVE CANADA

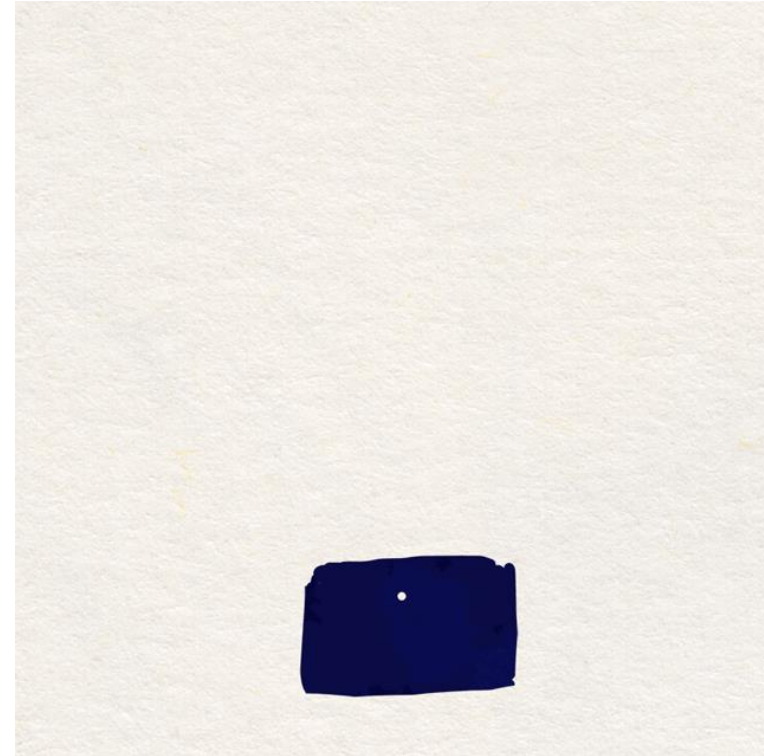


New York Passive House Passive House California Passivehouse Canada Passive House Institute

# From a research project...



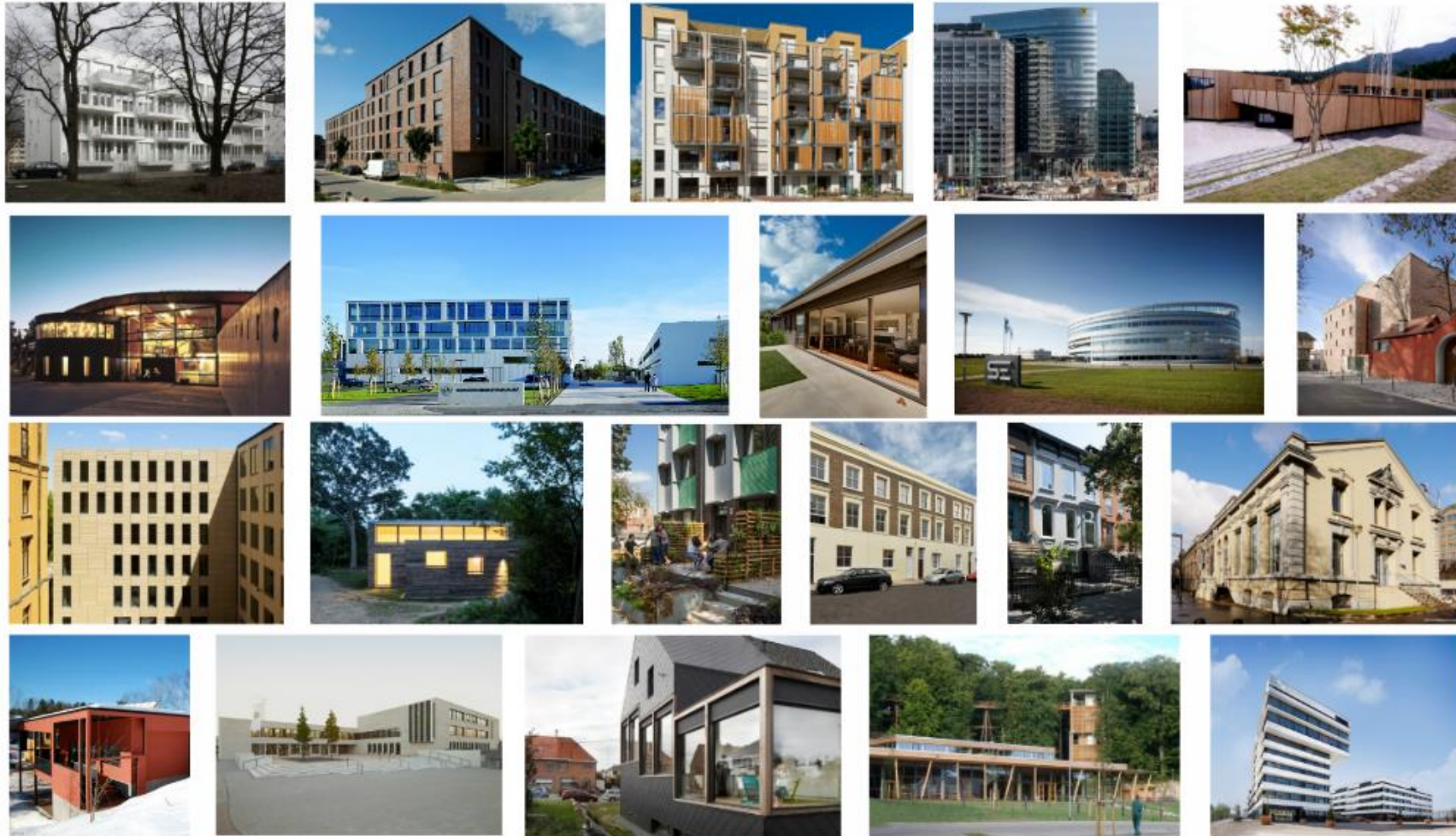
Photo: Peter Cook



[www.stephaniebrittnacher.de](http://www.stephaniebrittnacher.de)

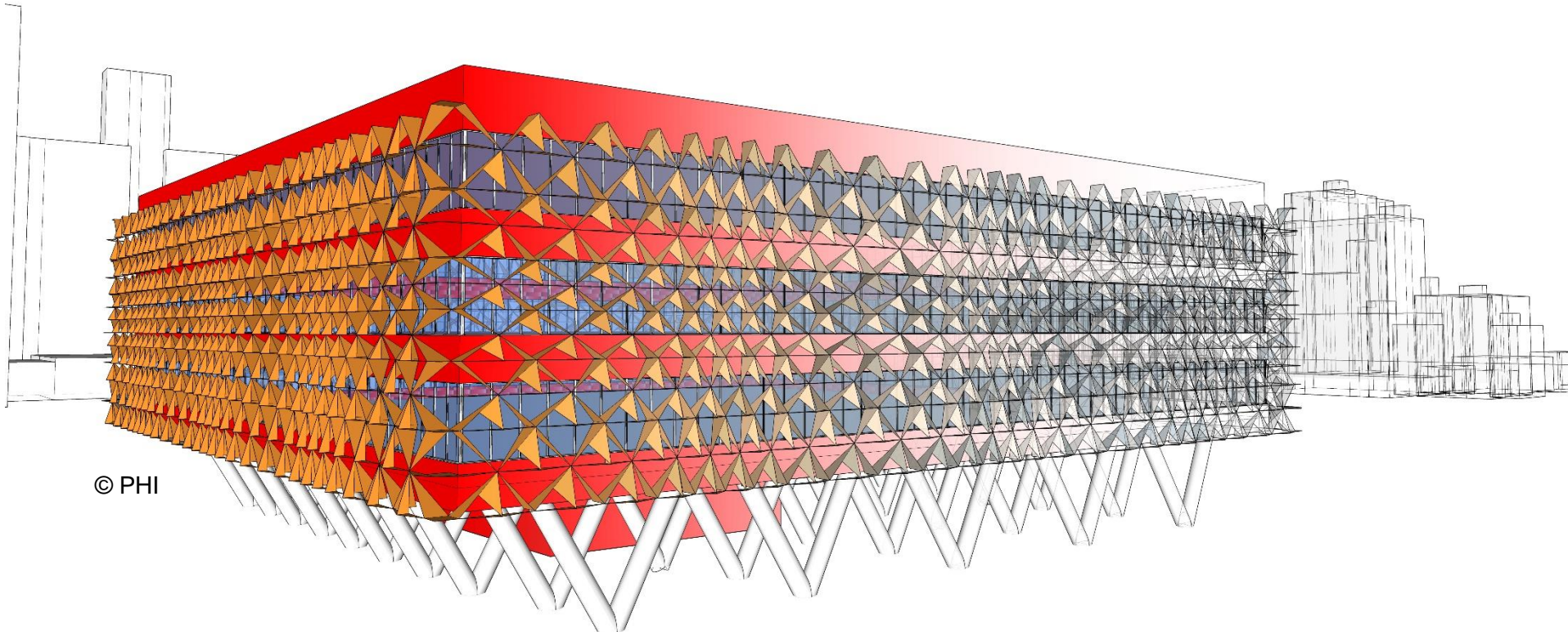
# From a research project...

## ... to an international journey

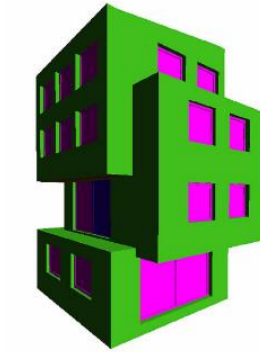
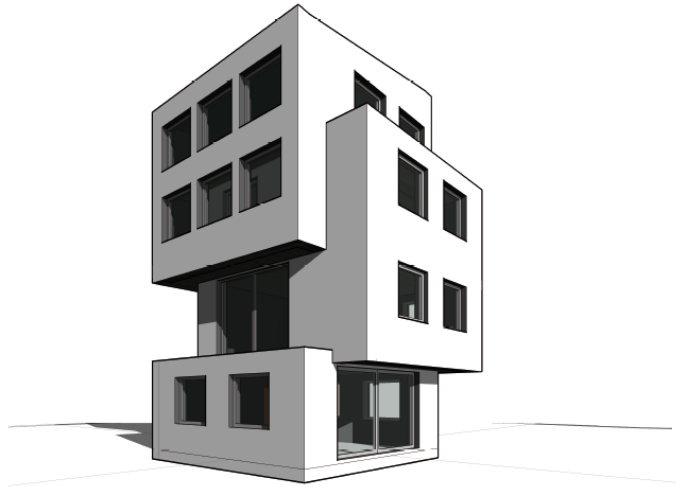


Plugin for the 3D design software SketchUp

Especially relevant for larger developments  
and complex shading analysis



allows import from Revit / ArchiCAD / Vectorworks / Rhino



# Reliable energy modeling: Conclusions

- Pick the right tool for the question at hand.
- 100% precision and accuracy is a false dream!  
It is not possible to predict all boundary conditions.  
Better to keep it simple and robust.
- There is a need for simple yet reliable modeling tools  
to quickly and effectively inform design decisions for high performance buildings
- Stationary energy balance is a suitable and proven methodology  
PHPP as example of a tried and tested tool in practice.

# Reliable energy performance modeling for design guidance is possible!

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