stichting W/E adviseurs

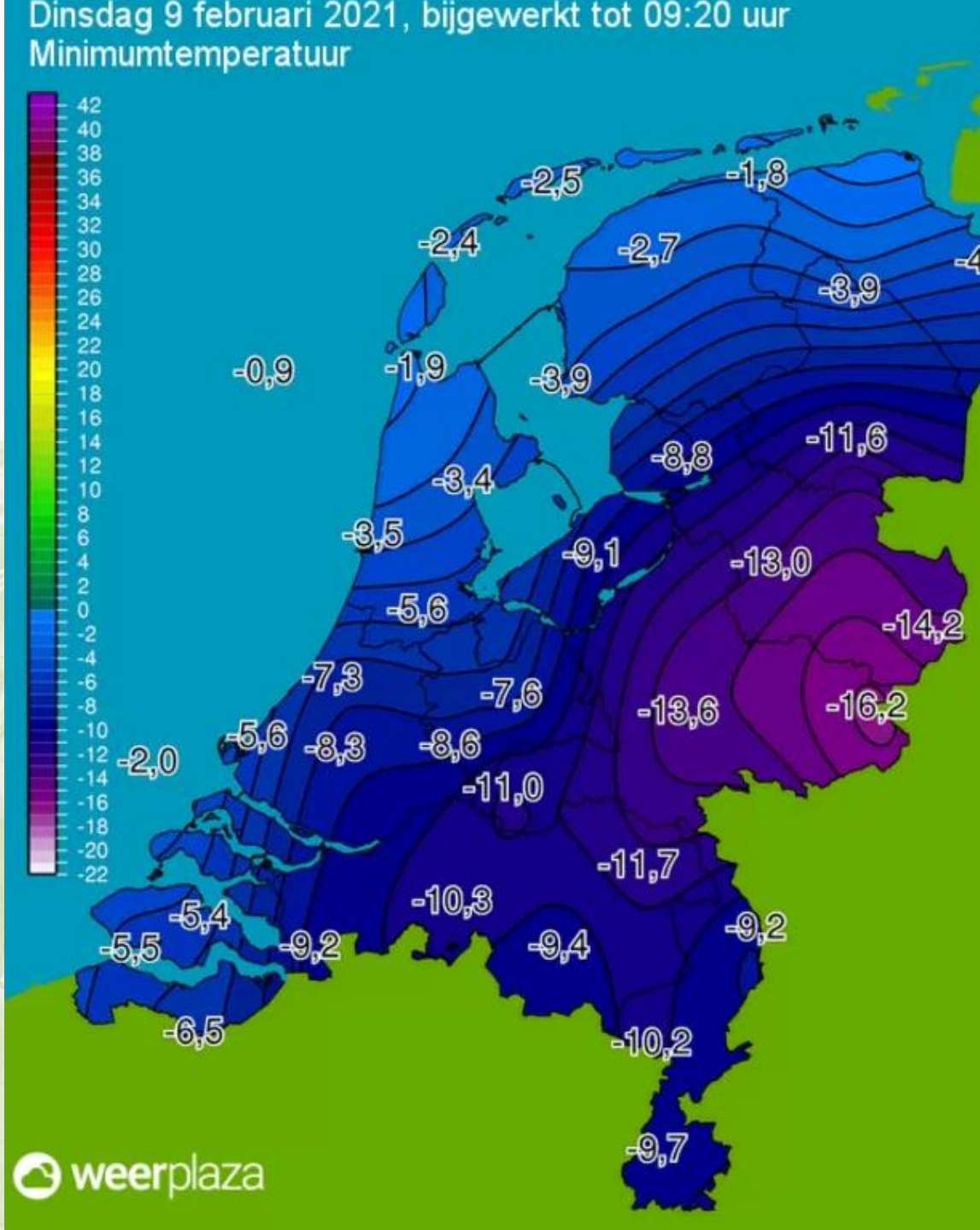
How to prevent overheating in dwellings

TO_{juli}-requirement in Building Code (Bouwbesluit)

Pieter Nuiten

10 February 2021

nuiten@w-e.nl



Who is W/E adviseurs?

Organisation	Independent foundation | since 1979
Mission	Contribute to a sustainable built environment
Motto	Making difficult matter easy *(Moeilijke materie makkelijk maken)*
What	Project consultancy | Process support | R&D
Focus	Energy transition | Circularity | Health
For whom	Ambitious contractors (municipalities, project developers, …)
With whom	40 colleagues
Locations	Utrecht – Eindhoven
Website	www.w-e.nl

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Overheating in dwellings

- Some background
- Two case studies

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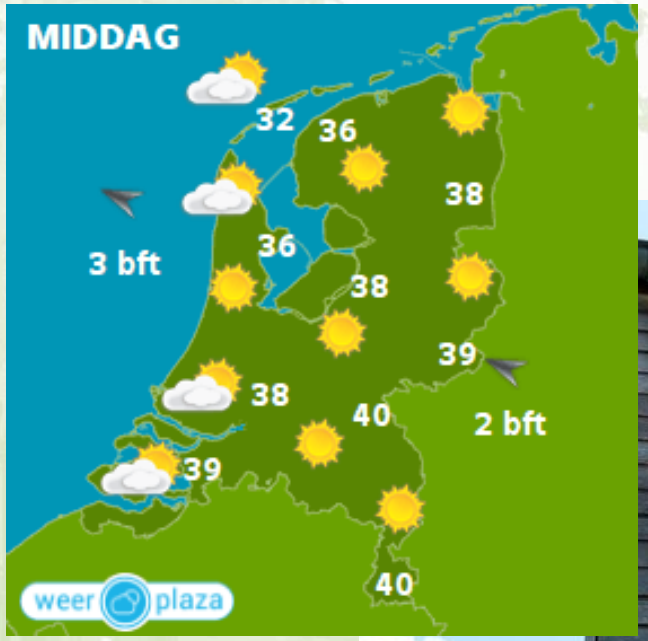

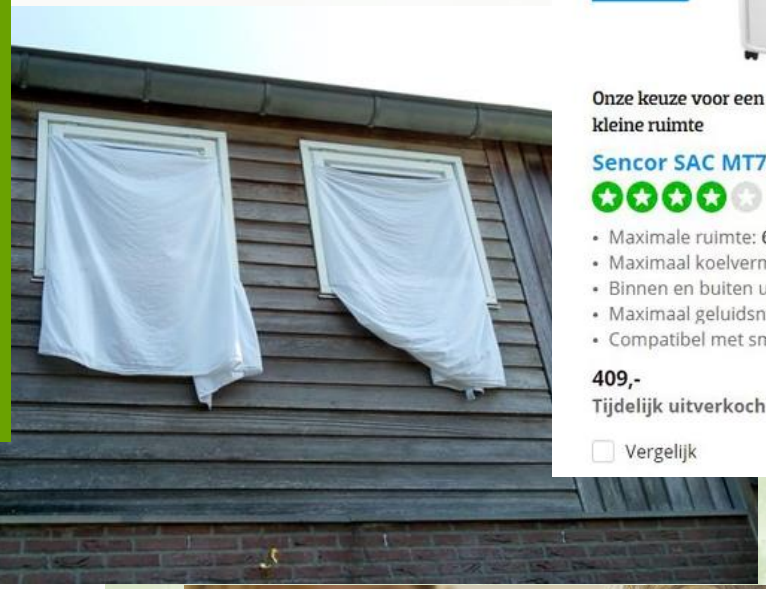

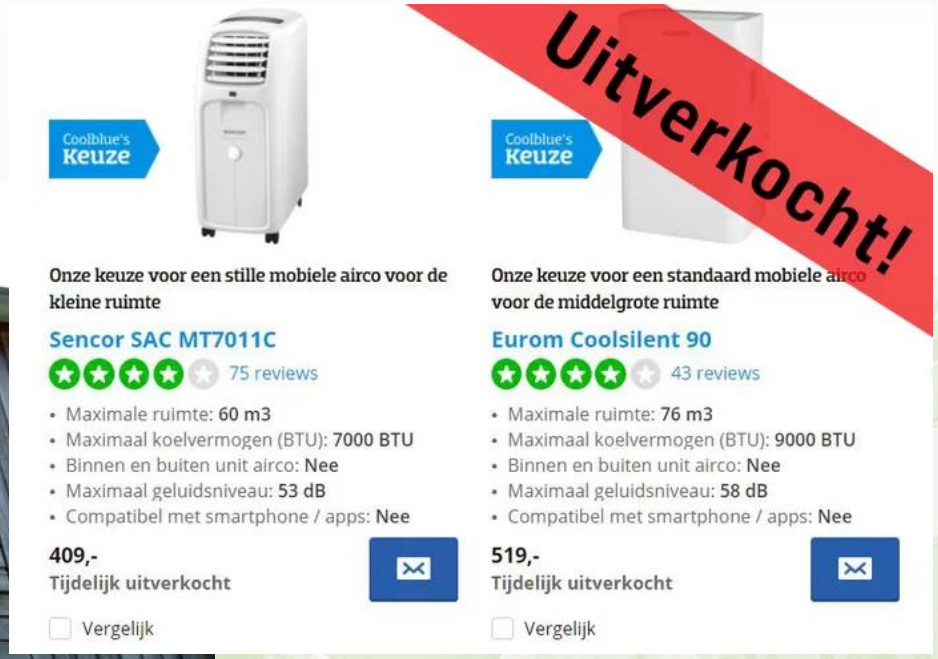

Hogere sterfte tijd hittegolf

9-8-2019 00:00

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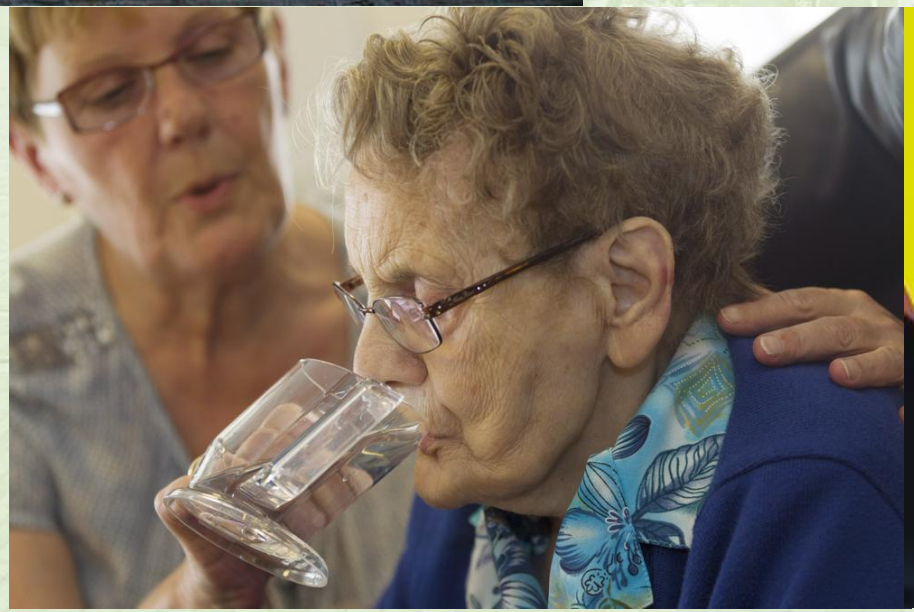
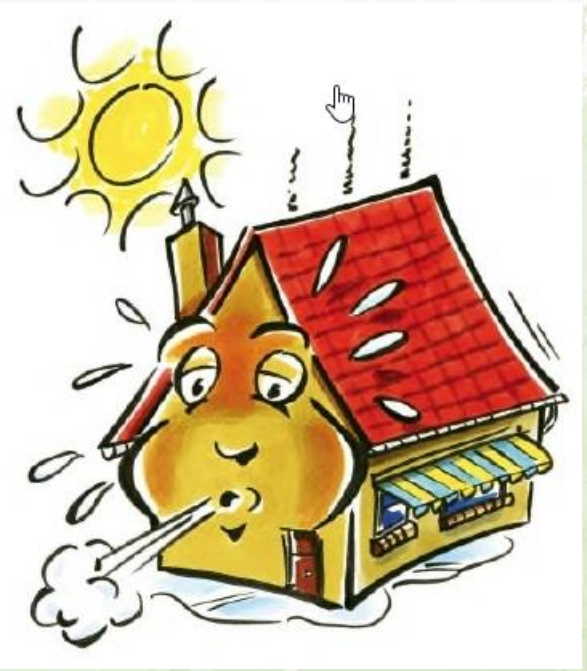
Tijdens de hittegolf in week 30 van 2019 overleden 2 964 personen. Dit zijn bijna 400 personen meer dan in een gemiddelde week in de zomerperiode. Tijdens de hittegolven in 2006 overleden per week bijna evenveel personen extra. Doordat er nu meer ouderen zijn, is de extra sterfte relatief gezien beperkt. Dat meldt het CBS naar aanleiding van vragen uit de media, op basis van de voorlopige sterftecijfers per week.



Excessive overheating: TOjuli Why?



- Better insulation, better air tightness, less ventilation. Dwellings are warmer in winter, but also in summer.
- Outdoor temperatures rise due to global warming
- Amplification due to urban heat island
- Increasing urbanisation
- Population ages → Higher excess mortality
- Covid19: working at home
- Cooling not only comfort issue, but also health issue

→ Good building design is getting more important

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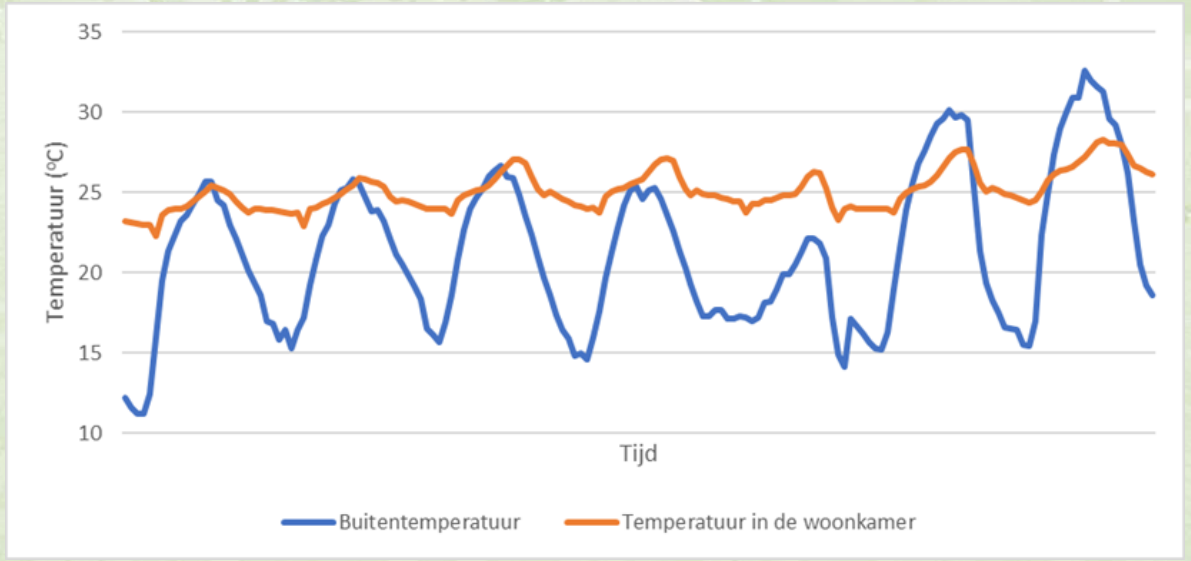
Calculations on overheating

- Building simulation, dynamic model
- Schematisation of entire dwelling
- Hourly values of outdoor and indoor temperature
  - And lots of other parameters!



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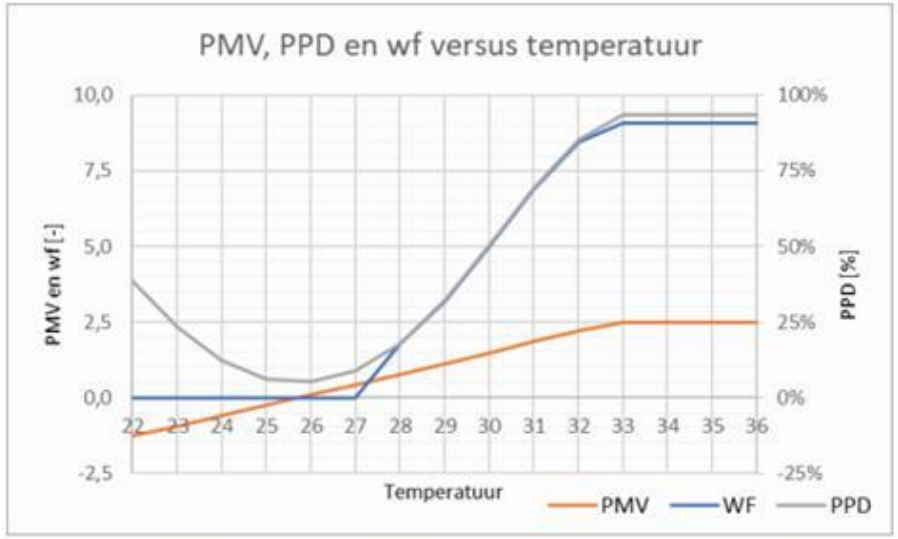
Requirement

- When is it ‘too warm’?
- Maximum of 450 GTO-hours/year (building simulation)
  - GTO: Gewogen Temperatuur Overschrijdingsuren (weighted temperature overshoot hours)



Figuur 5 *Verband PMV (linker-as), PPD (rechter-as), weegfactor GTO-uren (linker-as) en operatieve temperatuur (horizontale as; M = 1,1 met, I_{clo} = 0,5 clo, v = 0,15 m/s, RV = 50%)*

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Building code: TO_{juli}-requirement

- TO_{juli} is simplified indicator for risc of excessive heating
  - TO = TemperatuurOverschrijding (Temperature Overshoot)
  - Correlation TO_{juli} and GTO-hours
- Requirement $TO_{juli;max} \leq 1,2$
  - For each orientation of the facades
  - For each individual dwelling/apartment
- Don’t take this lightly. Probably harder than BENG (NZEB) 1-2-3
- Alternatives (in Building Code)
  - Dynamic building simulation (similar requirements, but can help)
  - Active cooling systems (like floor cooling/heat pump, air conditioning) in the entire dwelling

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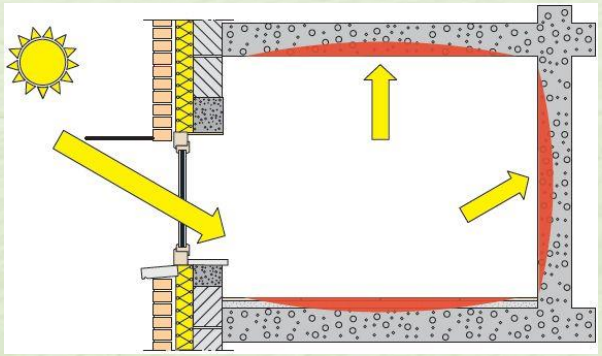
Indoor temperature: heat balance

Heat gains

Internal loads

Heat prevention

Thermal storage



Heat loss

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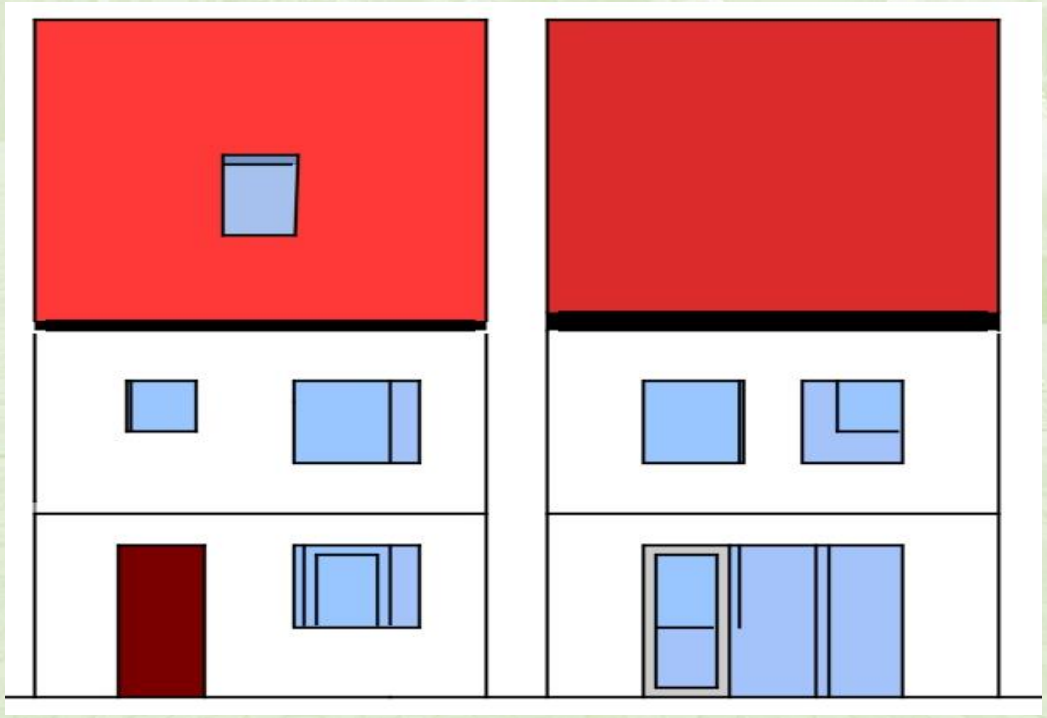
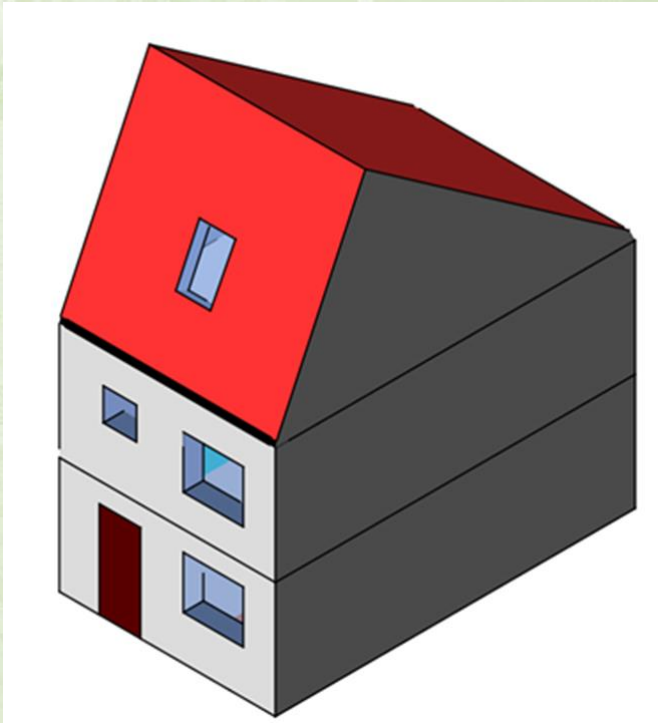
Case study 1: RVO reference dwelling

- Terraced dwelling | 110 m^2 user area | Rear at south-west
- Floor/facade/roof Rc = 3,7/4,7/6,3 m^2.K/W | HR^{++} glass
- Balanced ventilation system
- No solar blinds
- No overhang





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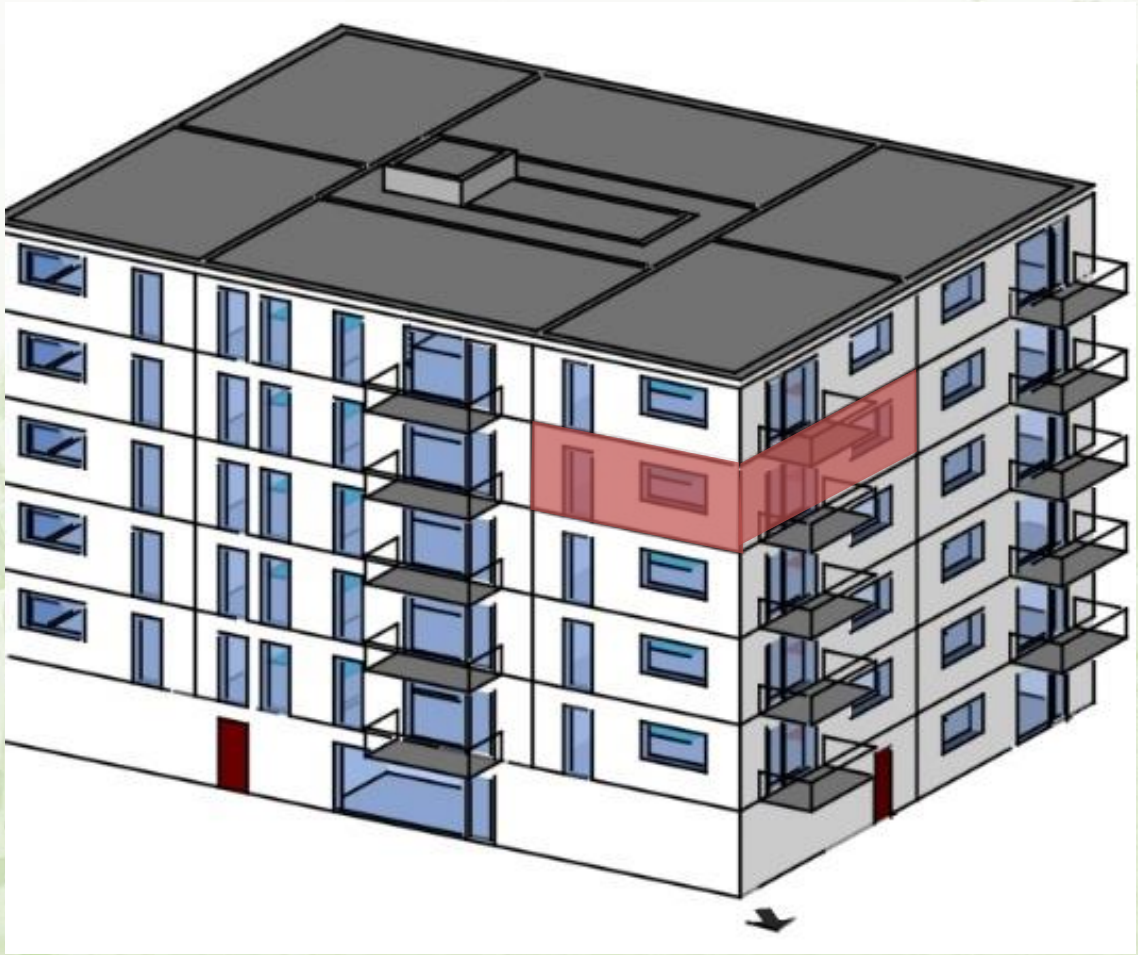
Case study 2: RVO reference apartment

- 92 m^2 user area
- Facade Rc = 4,7 m^2.K/W
- HR^{++} glass
- Facades at south-east / south-west
- Balanced ventilation system
- No solar blinds



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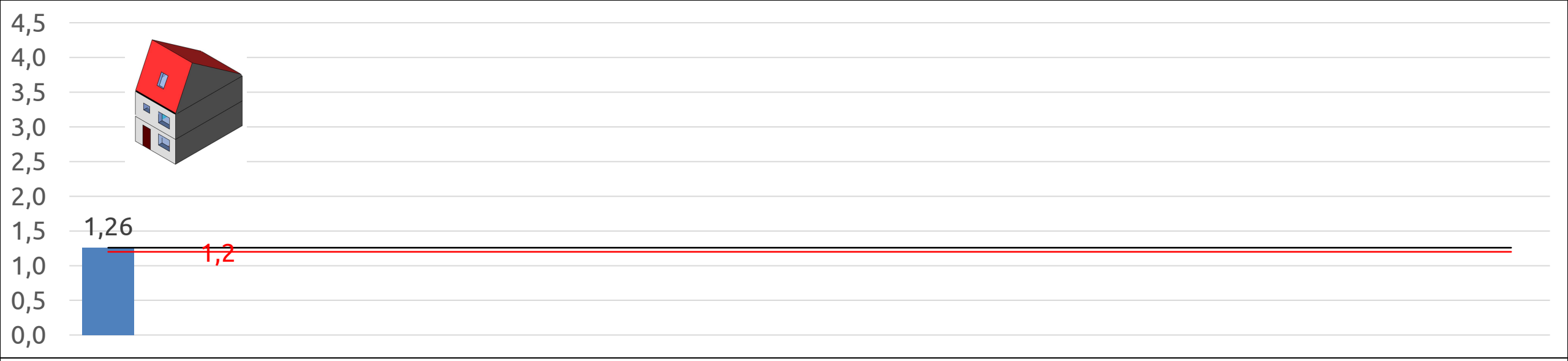

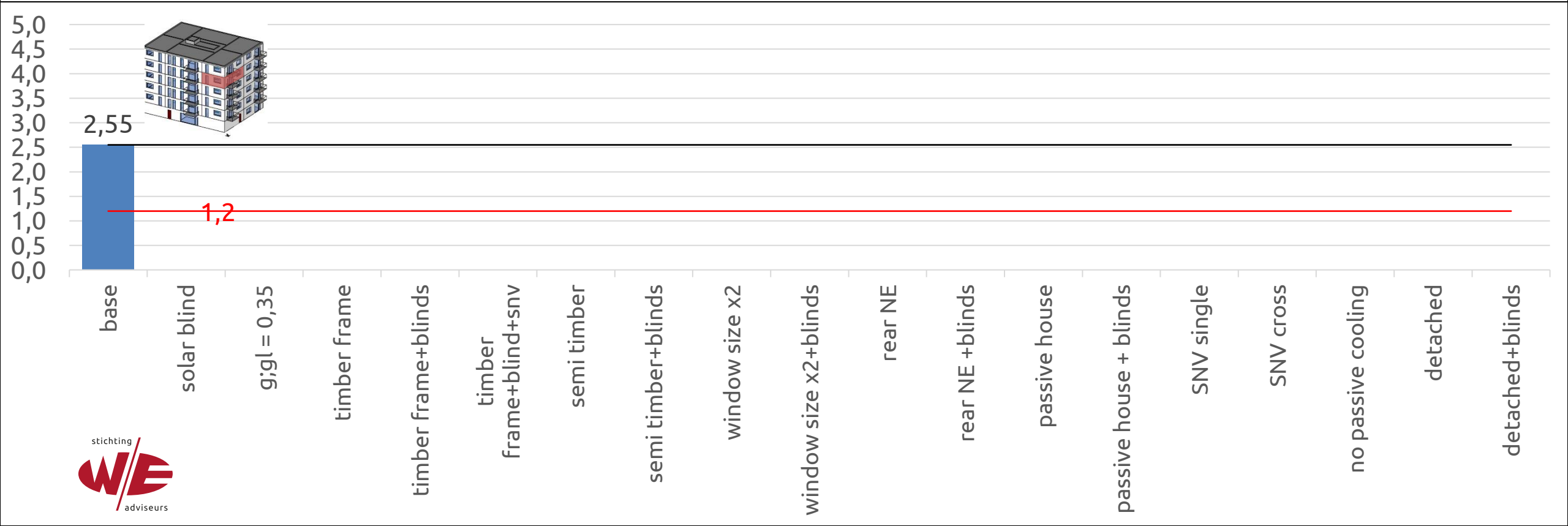

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Solar blinds

Type zonwering	Kleur	Criterium [a]	Fc
Screens (buiten toegepast)	Zwart, antraciet, donkerbruin	Ts<0,07	0,12
	Overige kleuren	Ts<0,17	0,20
	Wit	Ts>=0,17	0,25
Jaloezieën (buiten toegepast)	Zwart, antraciet, donkerbruin	Rs<0,3	0,05
	Overige kleuren	Rs<0,6	0,10
	Wit	Rs>=0,6	0,20
Gemetalliseerde weefsels (binnen toegepast)		Rs>0,72	0,45

a Ts betreft de zontransmissie, Rs betreft de zonreflectie, voor de gemetalliseerde weefsels gaat het om de reflectie van de metaallaag.

	Fc				
Type zonwering	N	NO, NW	O, W	ZO, ZW	Z
Uitvalschermen	0,50	0,45	0,35	0,35	0,35
Knikarmschermen	0,90	0,80	0,65	0,55	0,50

Fc: reduction factor voor solar admittance of solar blinds

g (glass + blinds) = Fc x g (glass)

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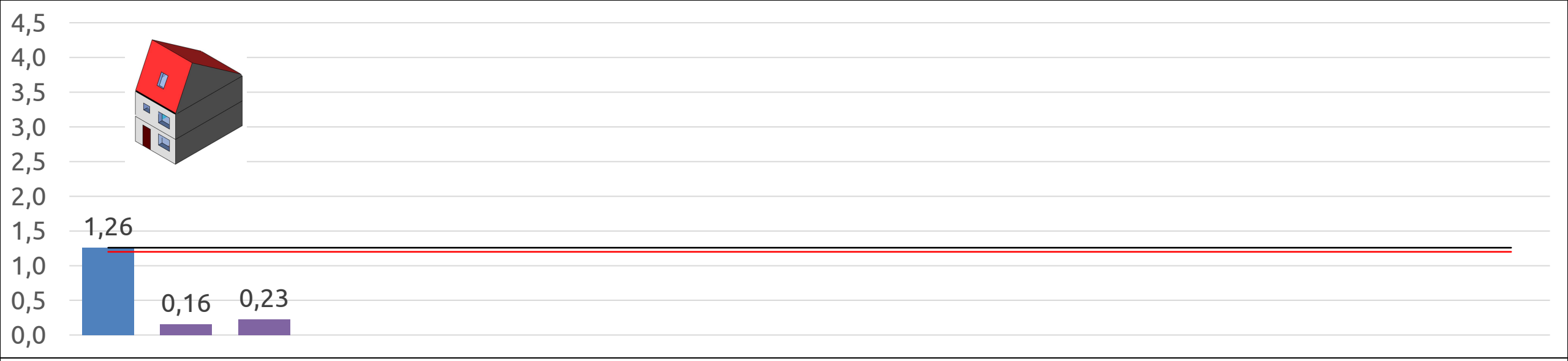

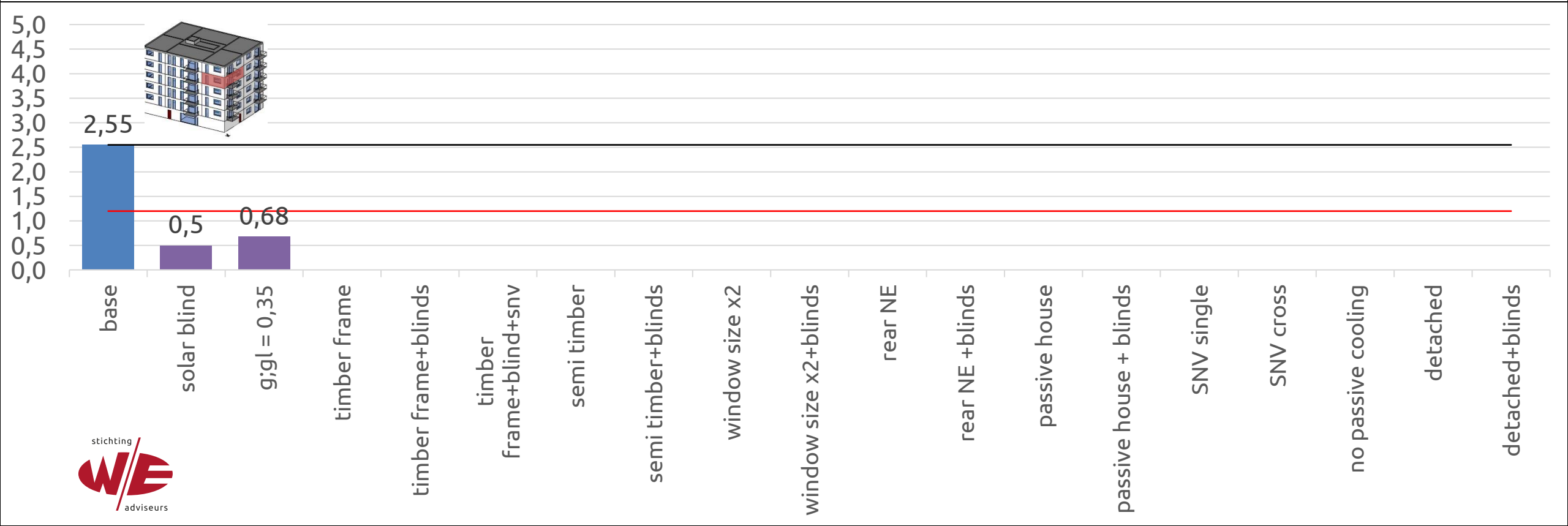

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Building mass / thermal capacity

- Traditional, heavy

- Light, timber frame

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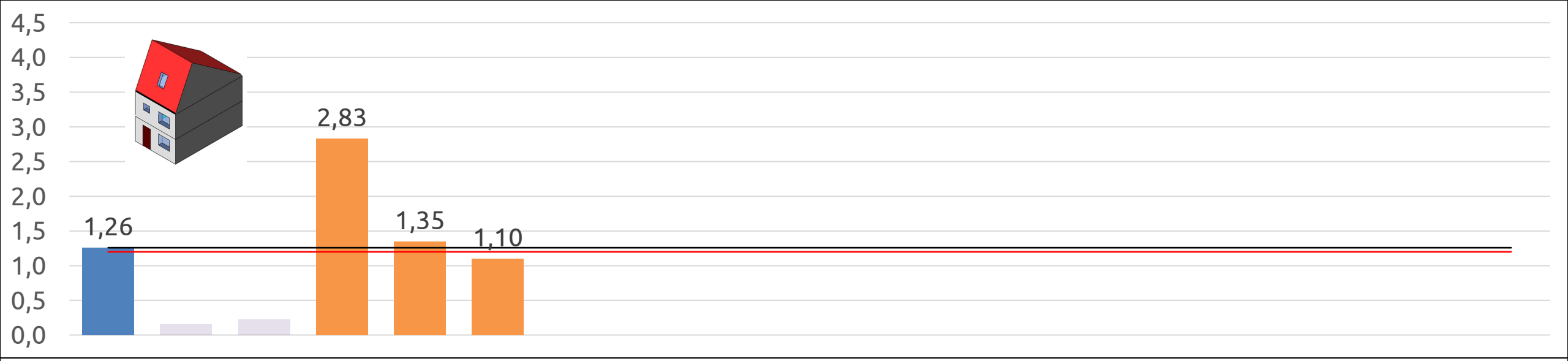

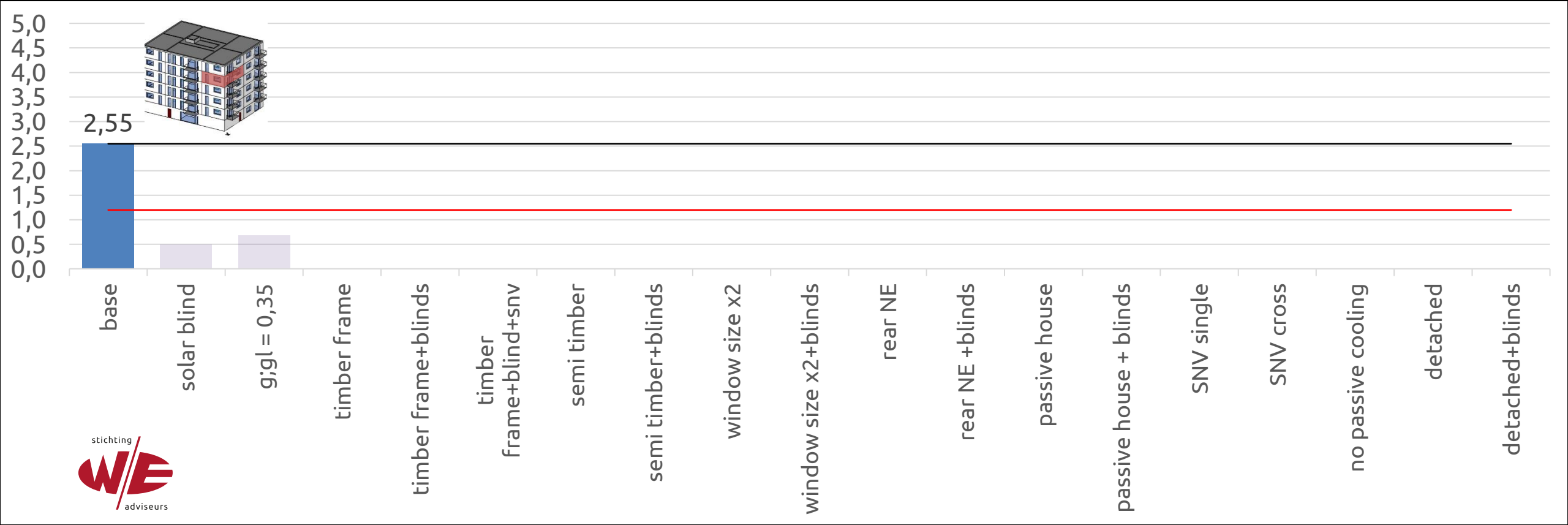

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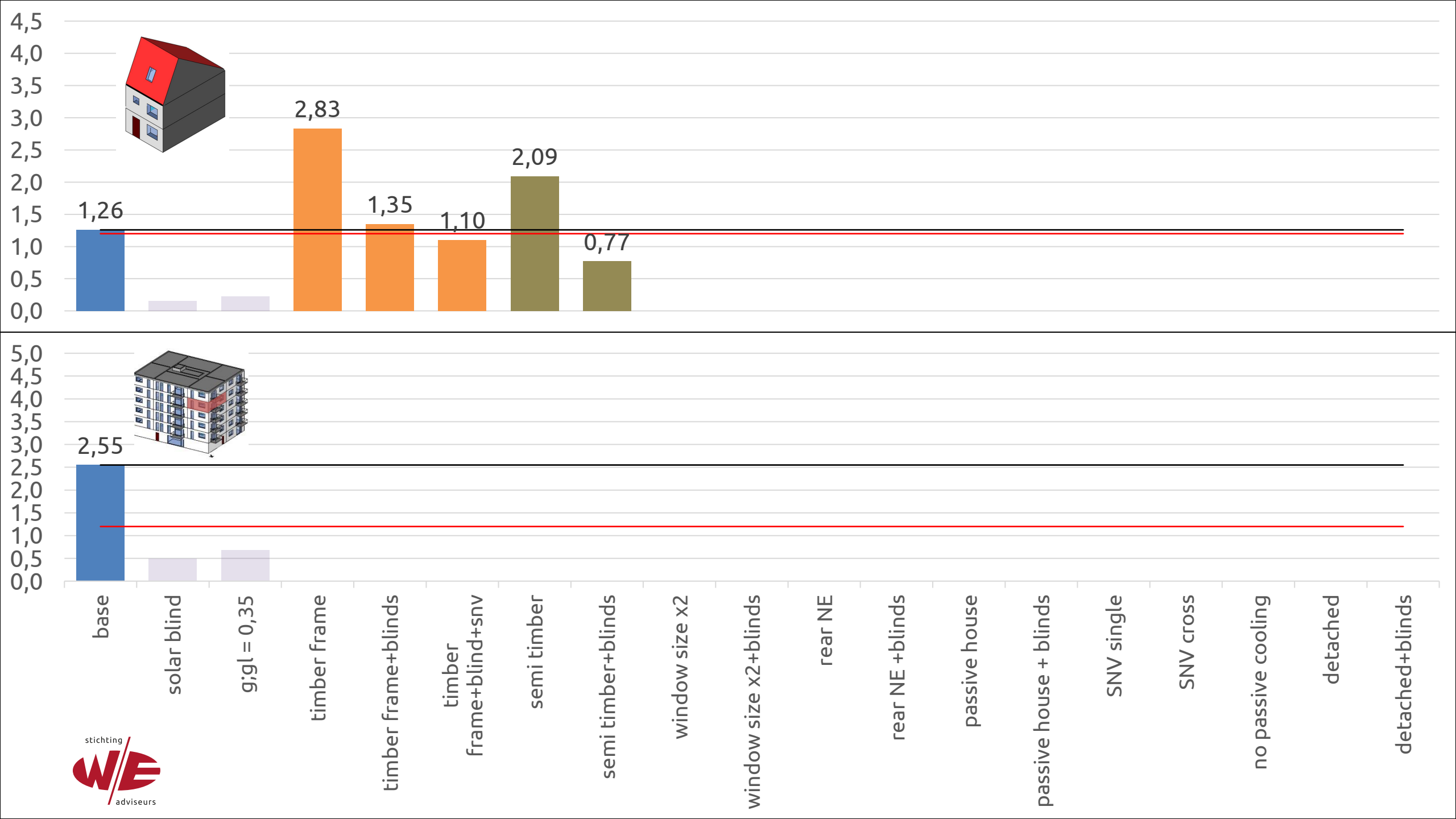

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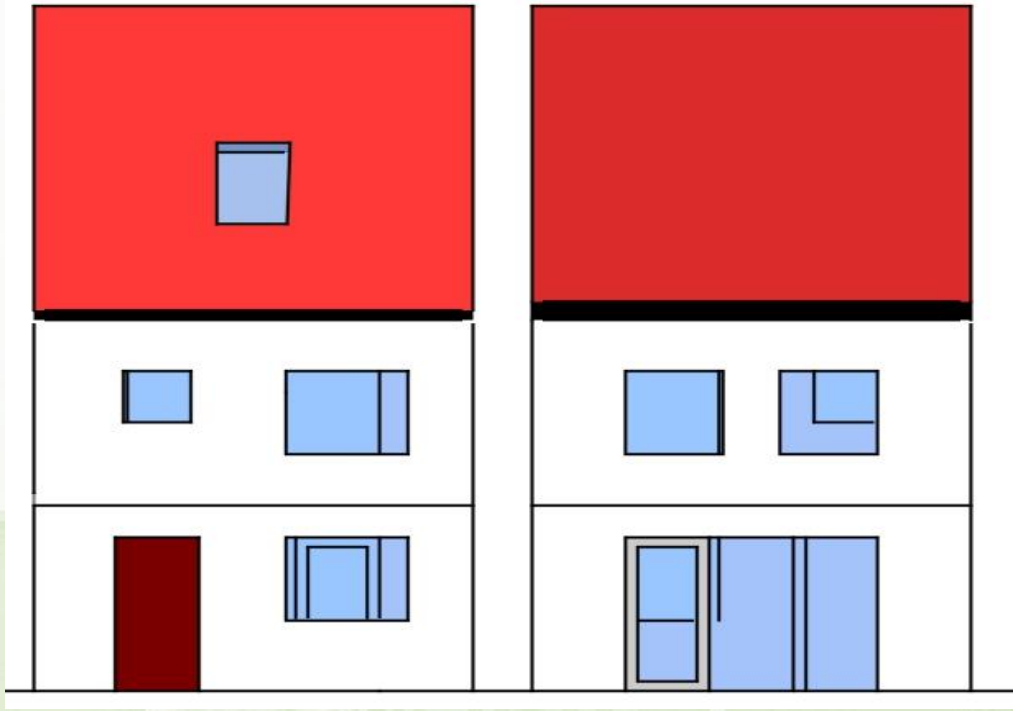
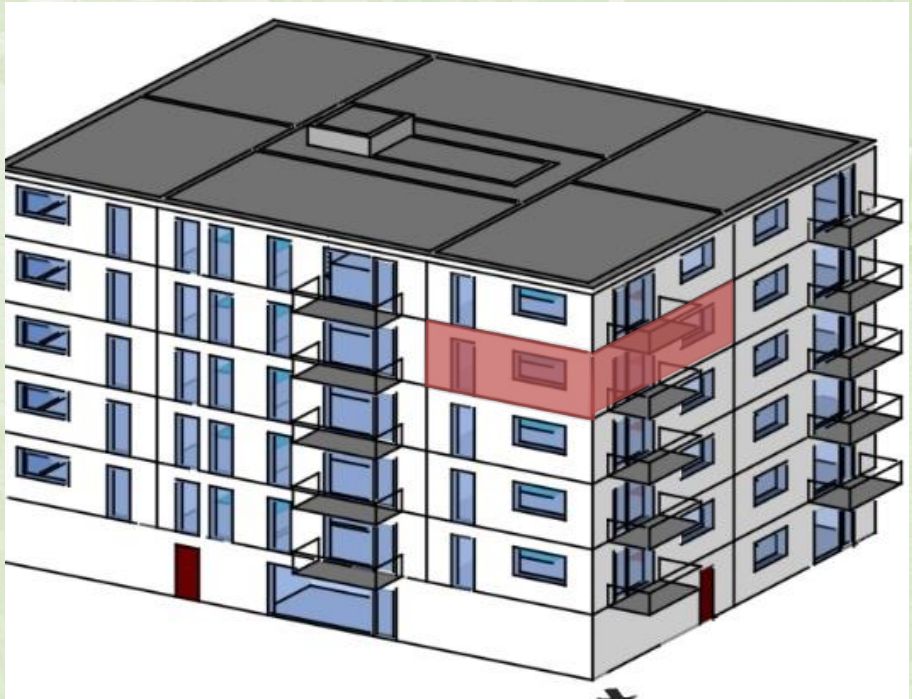
Window size

- Terraced dwelling
  - all windows x2
  - all windows x2 + solar blinds
- Apartment
  - all windows x1.5
  - all windows x1.5 + solar blinds





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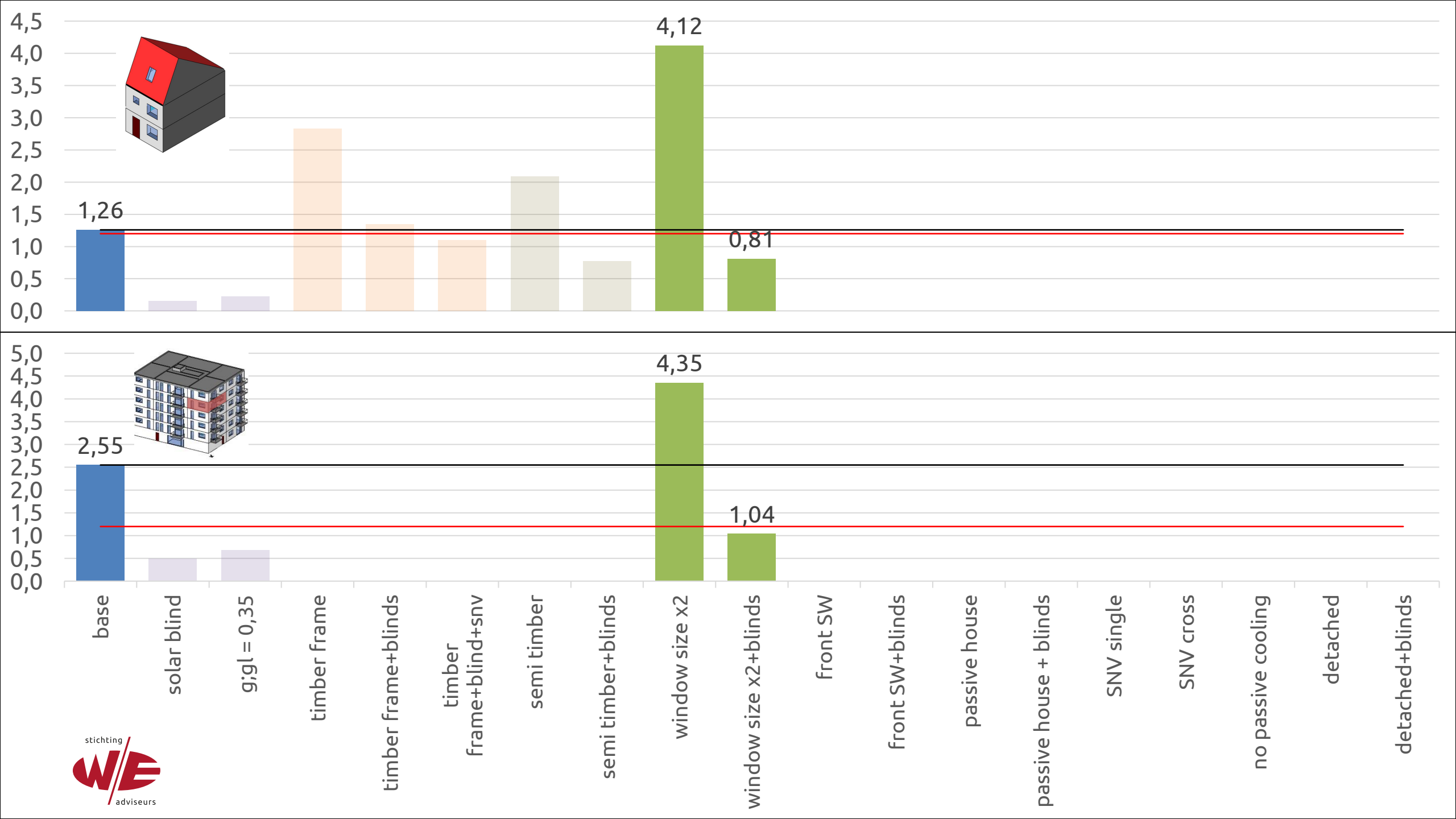
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base
solar blind
g;gl = 0,35
timber frame
timber frame+blinds
timber frame+blind+snv
semi timber
semi timber+blinds
window size x2
window size x2+blinds
front SW
front SW+blinds
passive house
passive house + blinds
SNV single
SNV cross
no passive cooling
detached
detached+blinds
stichting
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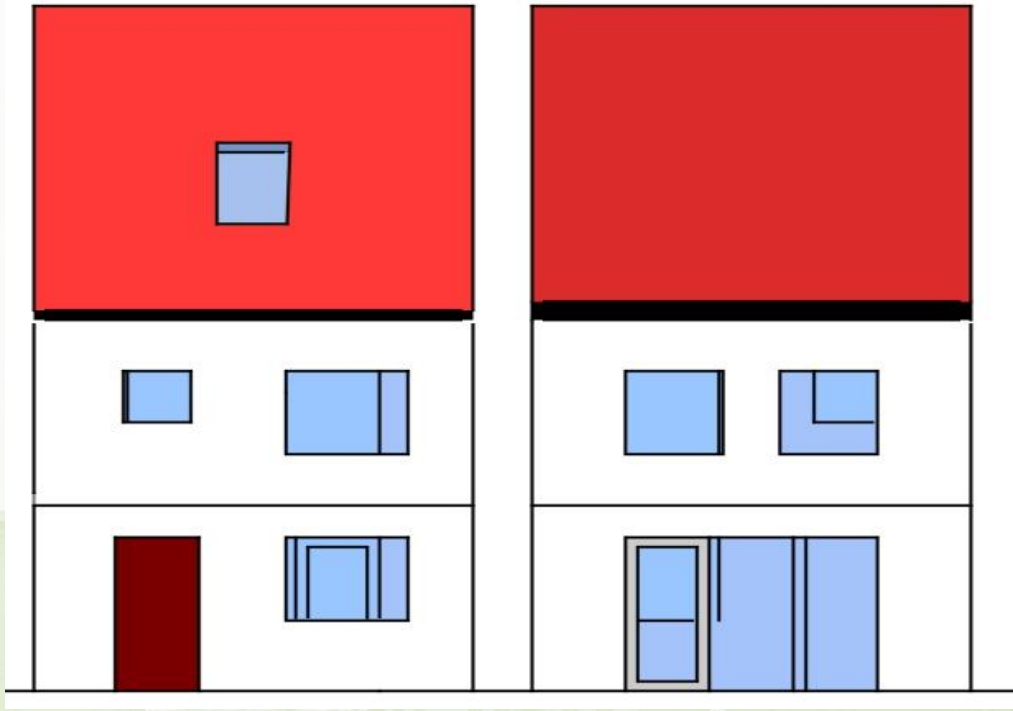
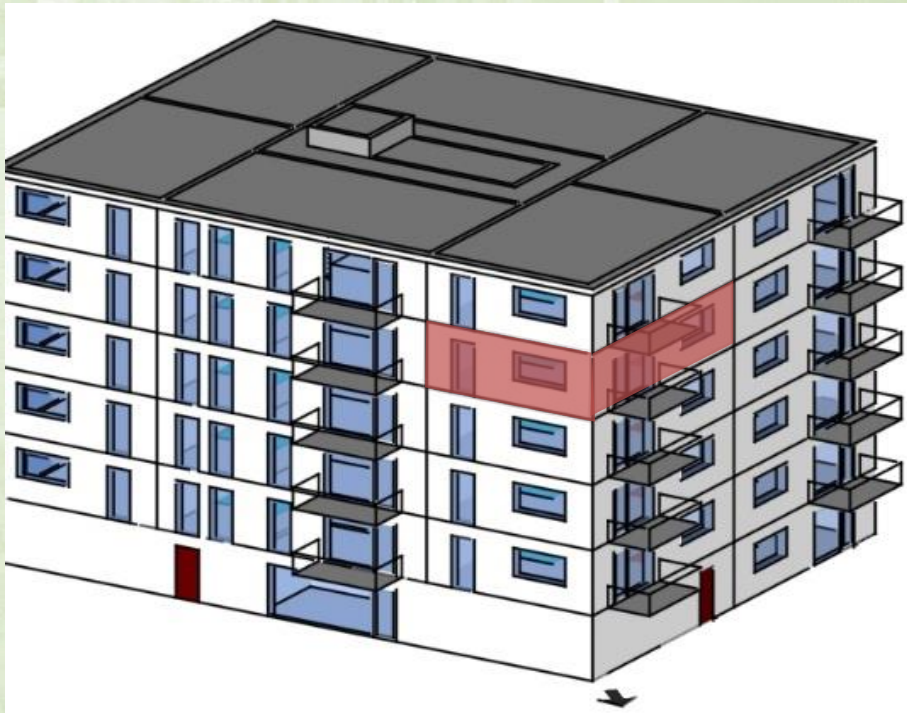
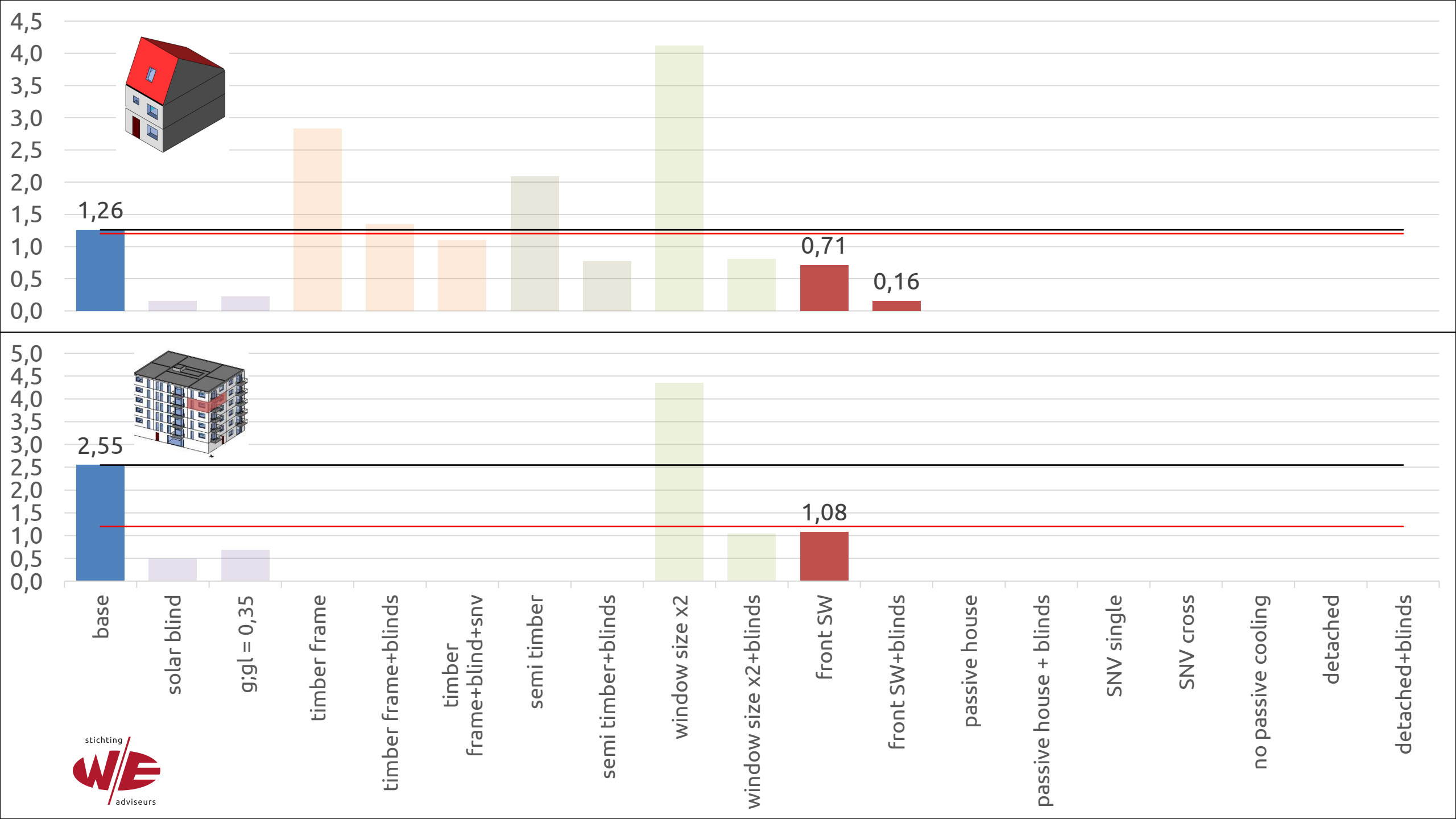
Orientation

- Terraced dwelling
  - Rear at north-east (base: south-west)
  - Plus solar blinds
- Apartment
  - Facades at north-east/ north-west (base: south-east/south-west)



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timber frame
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timber frame+blind+snv
semi timber
semi timber+blinds
window size x2
window size x2+blinds
front SW
front SW+blinds
passive house
passive house + blinds
SNV single
SNV cross
no passive cooling
detached
detached+blinds
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Insulation

- Terraced dwelling
  - Floor / facade / roof Rc = 8 / 8 / 10 m^2.K/W
  - Triple glass, $U_{glass+frame}$ = 0.7 W/m^2.K, g_{gl} = 0.5
- Apartment
  - Facade Rc = 8 m^2.K/W
  - Triple glass, $U_{glass+frame}$ = 0.7 W/m^2.K, g_{gl} = 0.5

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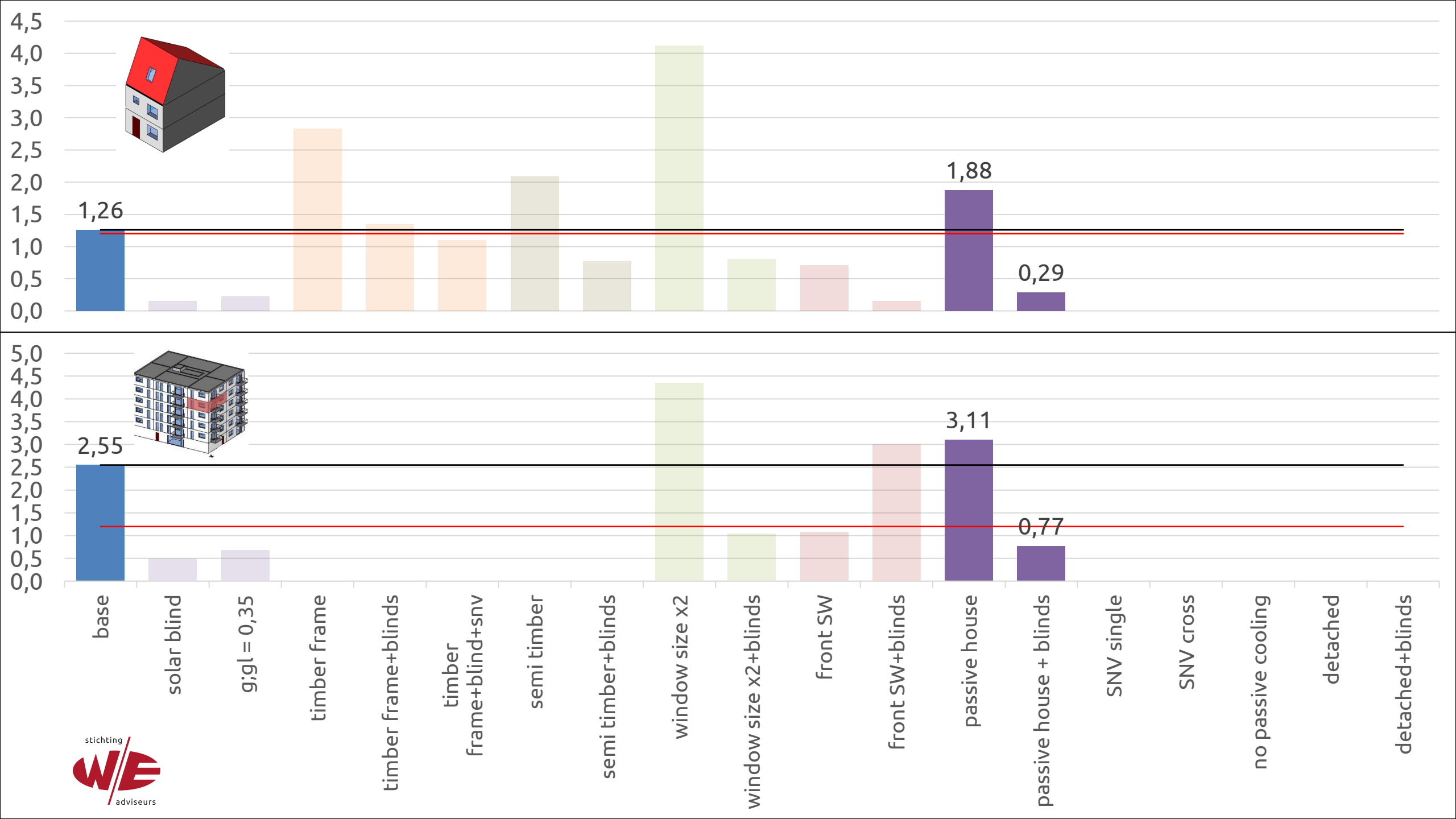
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timber frame
timber frame+blinds
timber frame+blind+snv
semi timber
semi timber+blinds
window size x2
window size x2+blinds
front SW
front SW+blinds
passive house
passive house + blinds
SNV single
SNV cross
no passive cooling
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detached+blinds
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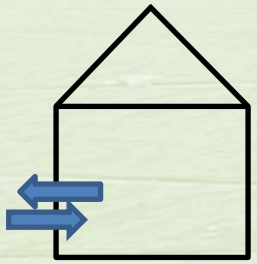
Summer night ventilation

- Rain-resistant, insect-resistant, burglar-resistant
- Single facade, cross

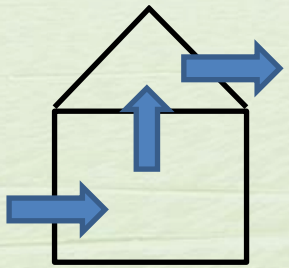
Summer night ventilation

Terraced dwelling

- Nett opening
  - Single: 0,5 m²
  - Cross: 2 x 0,5 m²
- Automatic control



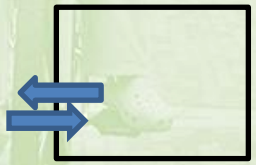
single



cross

Apartment

- Nett opening
  - Single: 0,5 m²
  - Cross: 2 x 0,5 m²
- Automatic control



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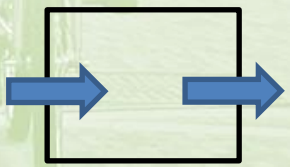

cross

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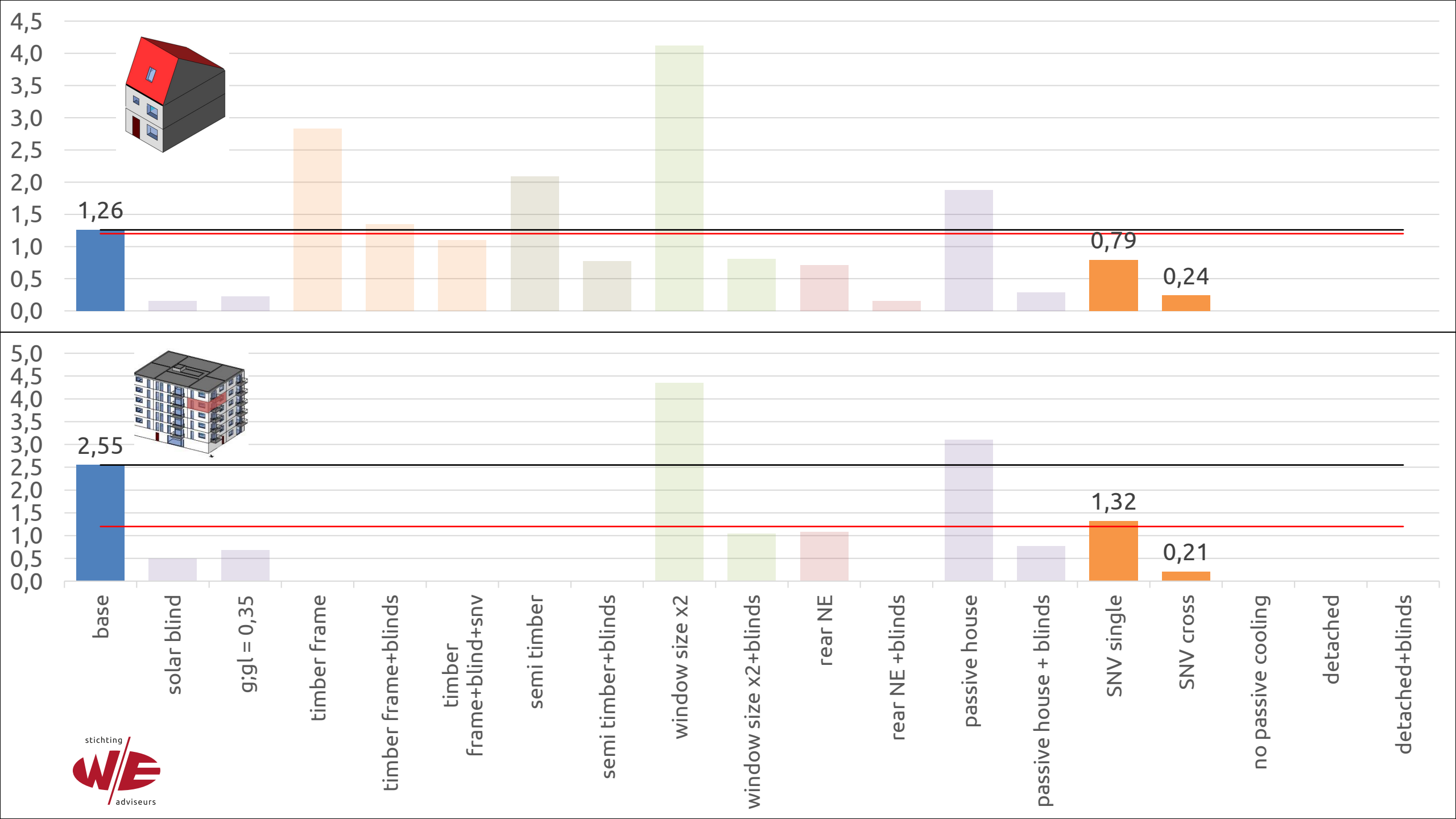
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base
solar blind
g;gl = 0,35
timber frame
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rear NE
rear NE +blinds
passive house
passive house + blinds
SNV single
SNV cross
no passive cooling
detached
detached+blinds
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Passive cooling through ventilation system

- Base
  - ventilation capacity 100% used for cooling during warm days
- Variant
  - not 100%

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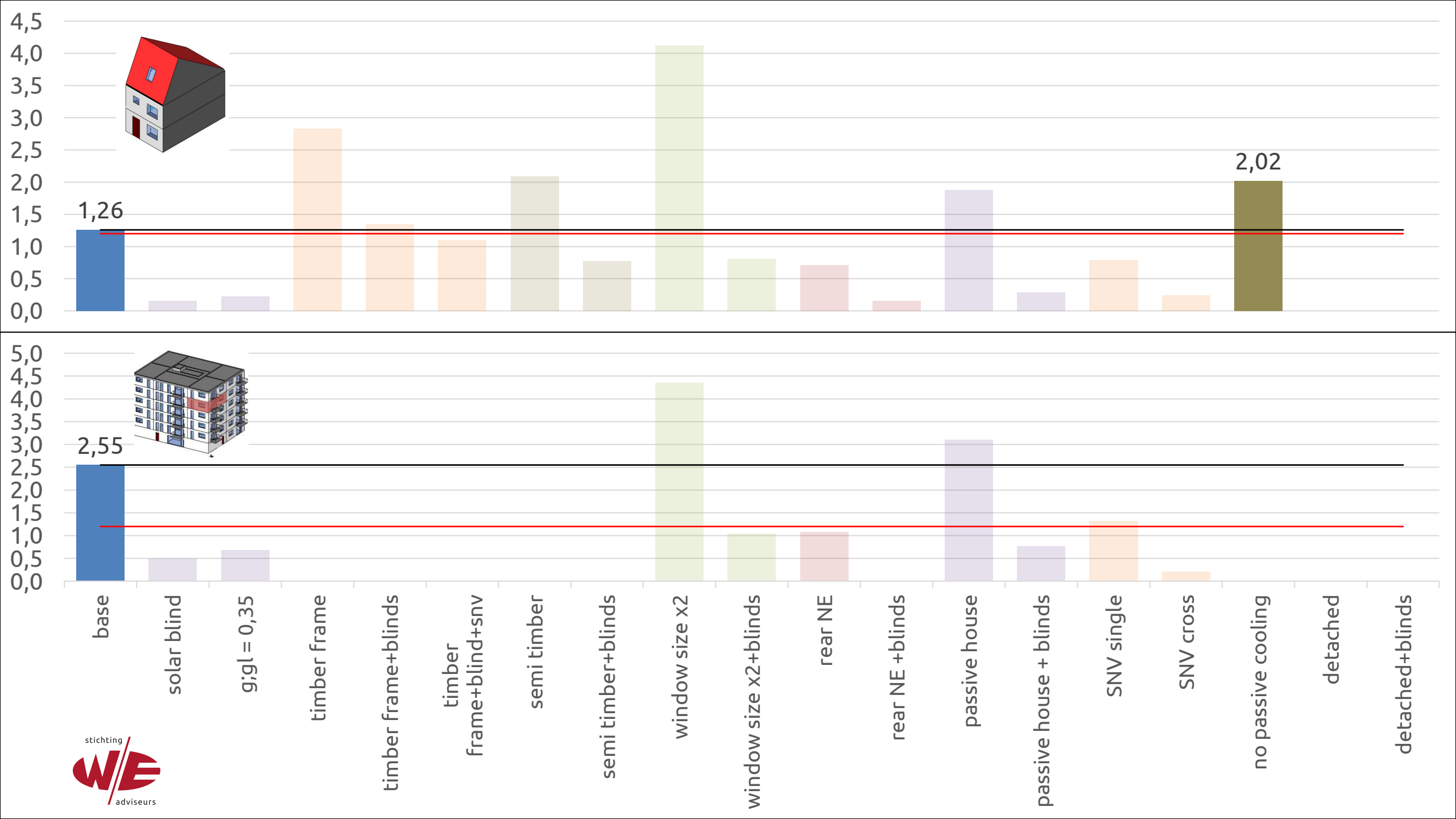
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solar blind
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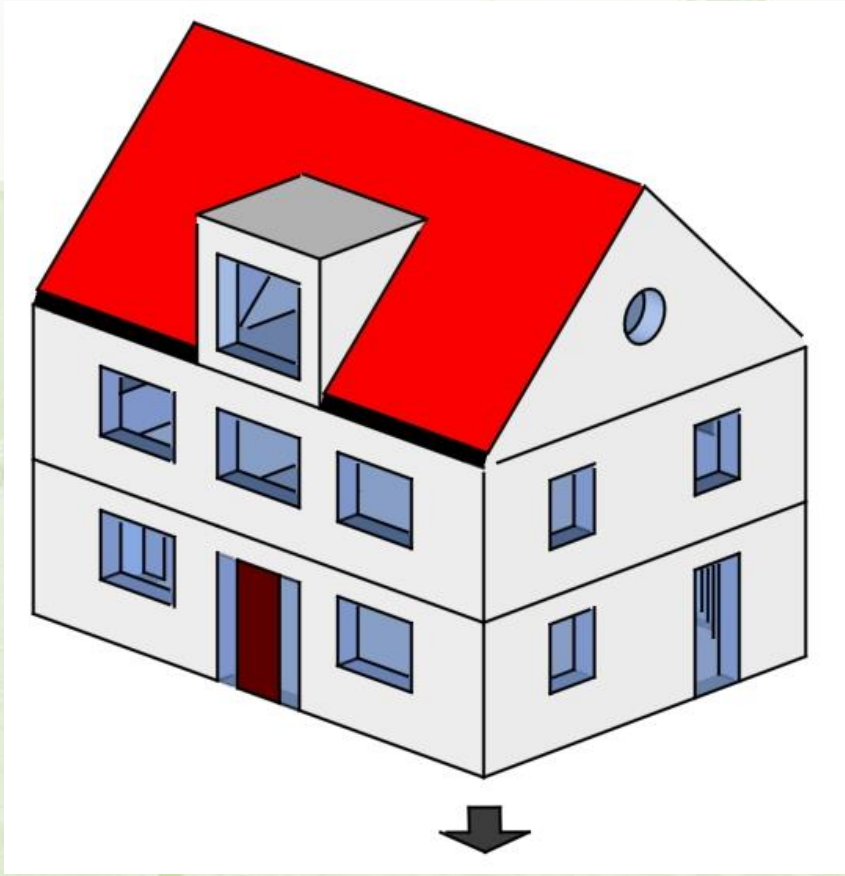
window size x2
window size x2+blinds
rear NE
rear NE +blinds
passive house
passive house + blinds
SNV single
SNV cross
no passive cooling
detached
detached+blinds

Different type of dwelling

- Detached dwelling
- Same design principles as terraced house
- Solar blinds



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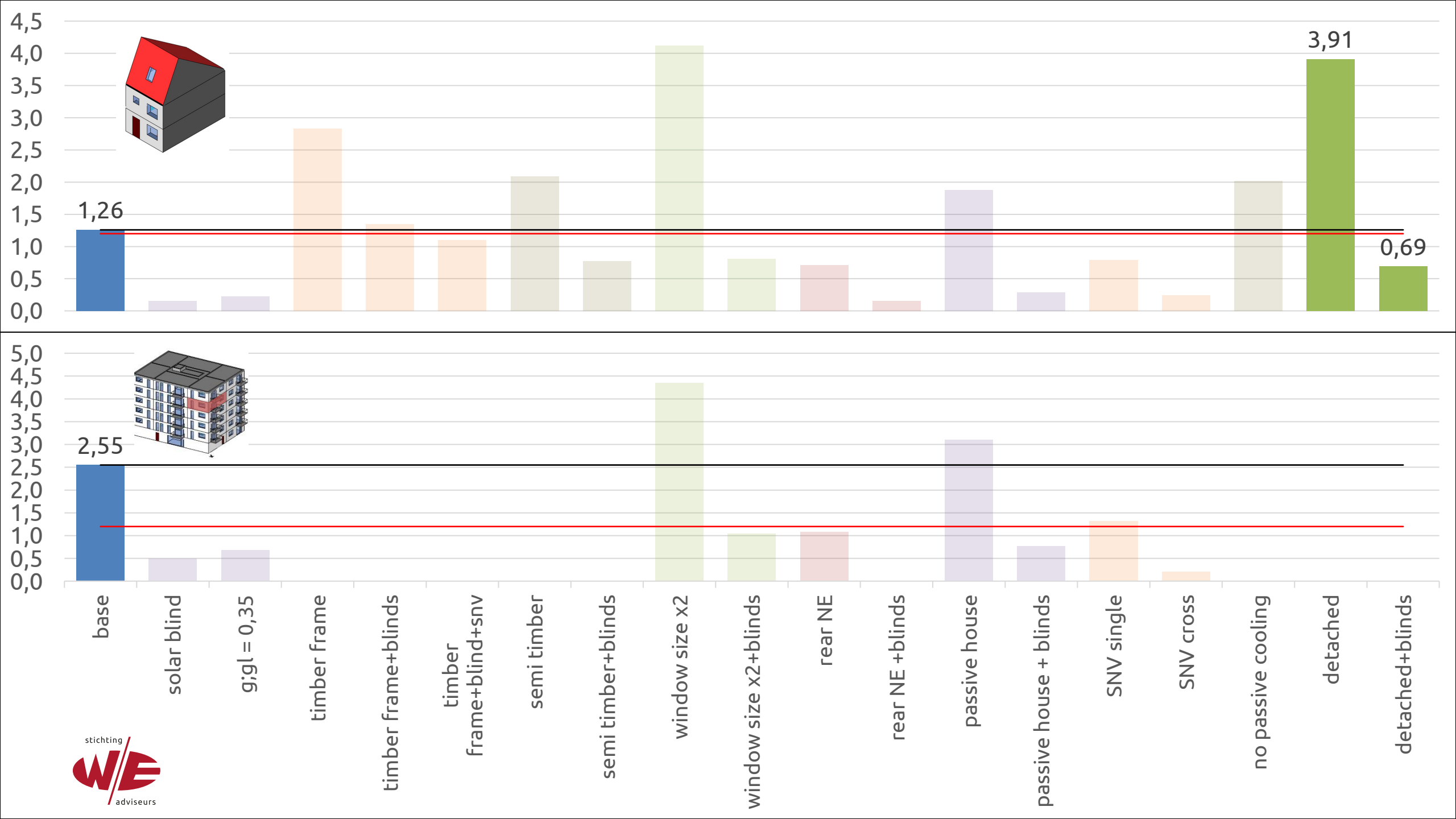
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solar blind
g;gl = 0,35
timber frame
timber frame+blinds
timber frame+blind+snv
semi timber
semi timber+blinds
window size x2
window size x2+blinds
rear NE
rear NE +blinds
passive house
passive house + blinds
SNV single
SNV cross
no passive cooling
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detached+blinds
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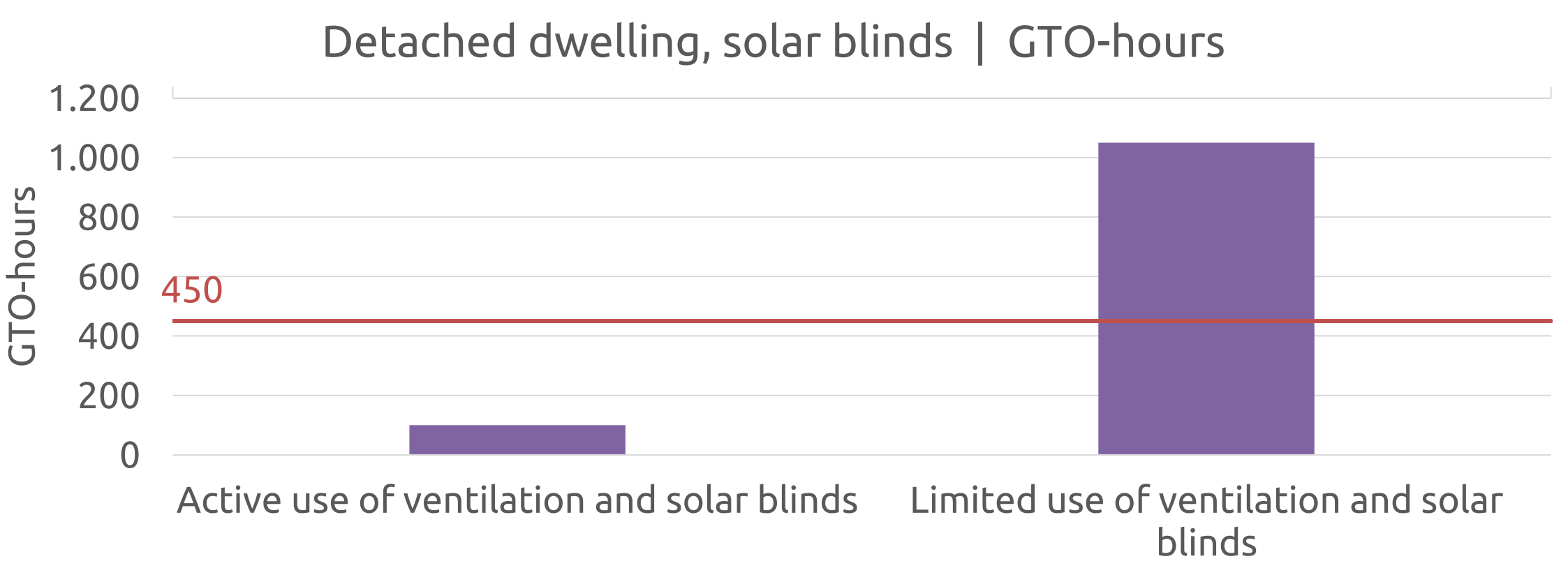
User behaviour

- No influence on TOjuli, does influence risc of overheating



There is more to overheating than TOjuli

- TOjuli is requirement for buildings
  → not for it's surroundings, nor for it's inhabitants
- Other measures to consider:
- *Building*
  - User behaviour
  - Internal heat load (electrical equipment), distribution within dwelling
  - Green roofs
  - Phase change materials
  - Earth, Wind & Fire concept by TU Delft
- *Surroundings*
  - Trees (shading, evaporation)
  - Water

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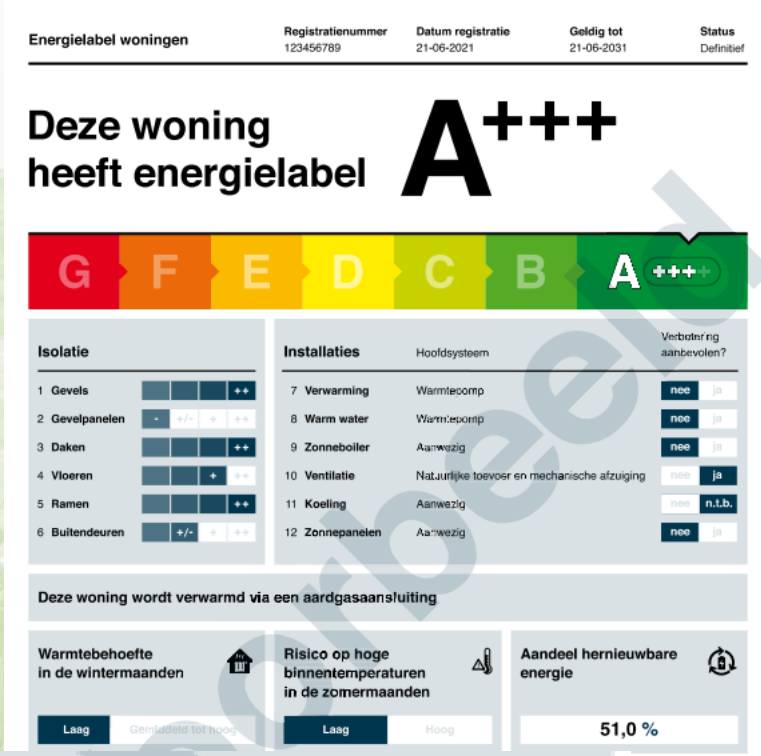
Future developments

- Large scale application in new dwellings
- Refinement of methodology
  - Thermal zones within a dwelling
  - Update of NTA 8800
  - Outdoor climate 2085 (TU Eindhoven)
- Applicability in existing dwellings (W/E)
- Validation of method
  with measurements (HvAmsterdam)



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Summary

- Importance of thermal comfort in summer has been acknowledged
- New requirement in Building Code per 1 January 2021
- Simplified method, based on BENG calculation
- Requirement: TO_{juli}-indicator ≤ 1,2

- Design aimed at summer situation, not just winter
- Solar shading, summer night ventilation are effective
- Active use of passive measurements

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Further reading …

- www.rvo.nl/onderwerpen/duurzaam-ondernemen/gebouwen/wetten-en-regels/nieuwbouw/energieprestatie-beng/indicatoren
- www.lente-akkoord.nl/zen-factsheet-zomercomfort-in-nieuwe-woningen/
- www.topsectorenergie.nl/nieuws/hittestress-verkenning-koudevraag-en-maatregelen-gebouwde-omgeving
- www.topsectorenergie.nl/tki-urban-energy/kennisbank/factsheets-koudetechnieken
- www.koelebuurt.nl
- www.iea.org/reports/cooling

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Questions?

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Blijf op de hoogte van de laatste ontwikkelingen over duurzaam bouwen!

Stichting W/E adviseurs Duurzaam Bouwen

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Of ga naar www.w-e.nl en abonneer je op onze nieuwsbrief!