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FACULTY OF ENGINEERING
AND ARCHITECTURE

DEPARTMENT OF ARCHITECTURE AND URBAN PLANNING
RESEARCH GROUP BUILDING PHYSICS AND CONSTRUCTION

ENERGETISCHE RENOVATIE VAN HISTORISCH WAARDEVOLLE GEBOUWEN

Prof. Nathan Van Den Bossche
Isabeau Vandemeulebroucke, Yanaika Decorte, Kjartan Van den Brande, Matthias Van Hove, Sam Hamels

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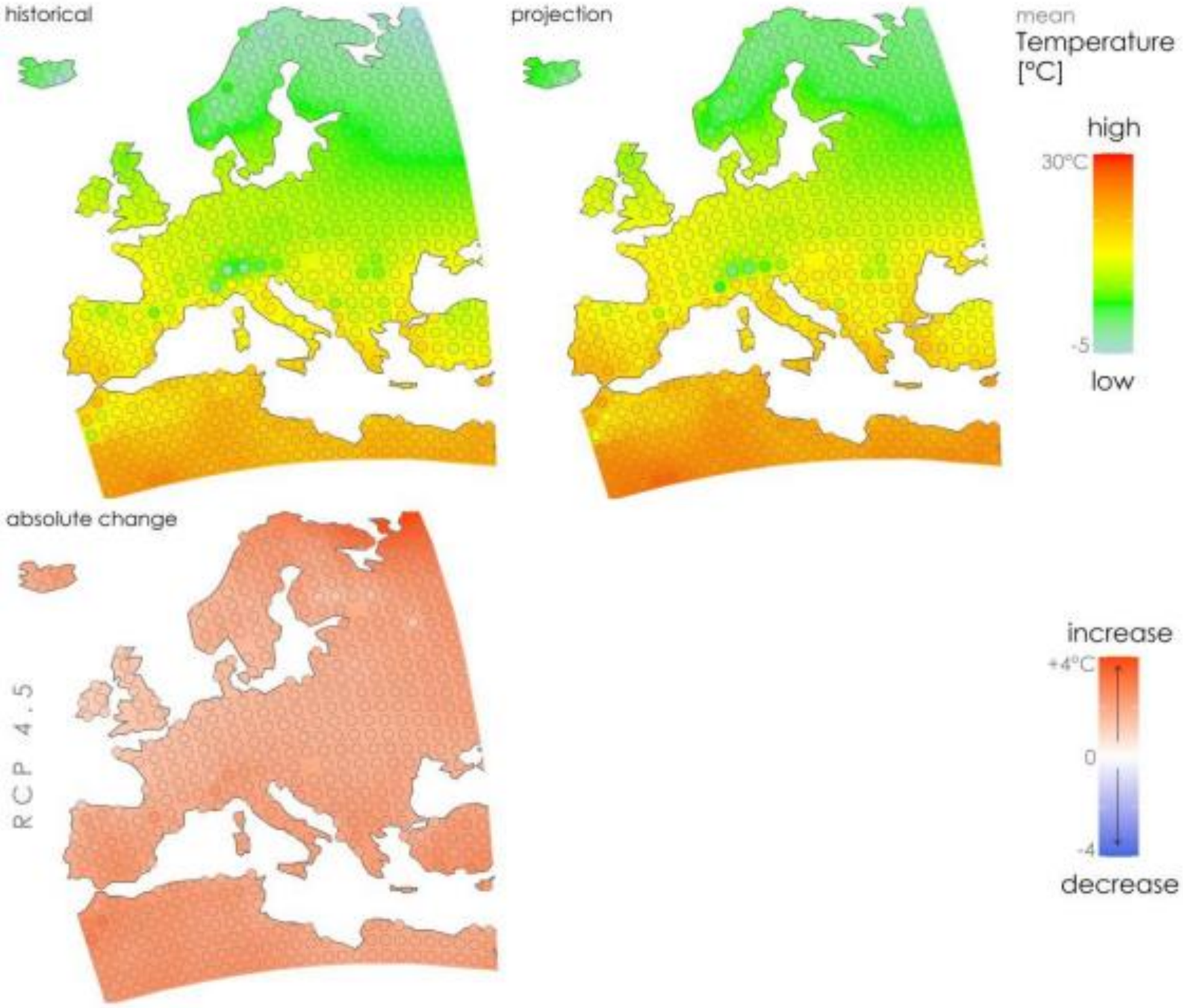
TEMPERATUUR

Climate-based

Mean temperature

There is a large variation in mean temperature across the studied domain. Temperatures are lower in the north compared to the south. Though, the mean temperature is also influenced by the Atlantic Ocean (i.e. higher mean temperatures), and orography, such as mountains (i.e. lower mean temperatures). In general, there is an increase in mean temperature over Europe and the Mediterranean between 1970-1999 (historical) and 2070-2099 (projection). The increase in temperature is not uniform over the domain.



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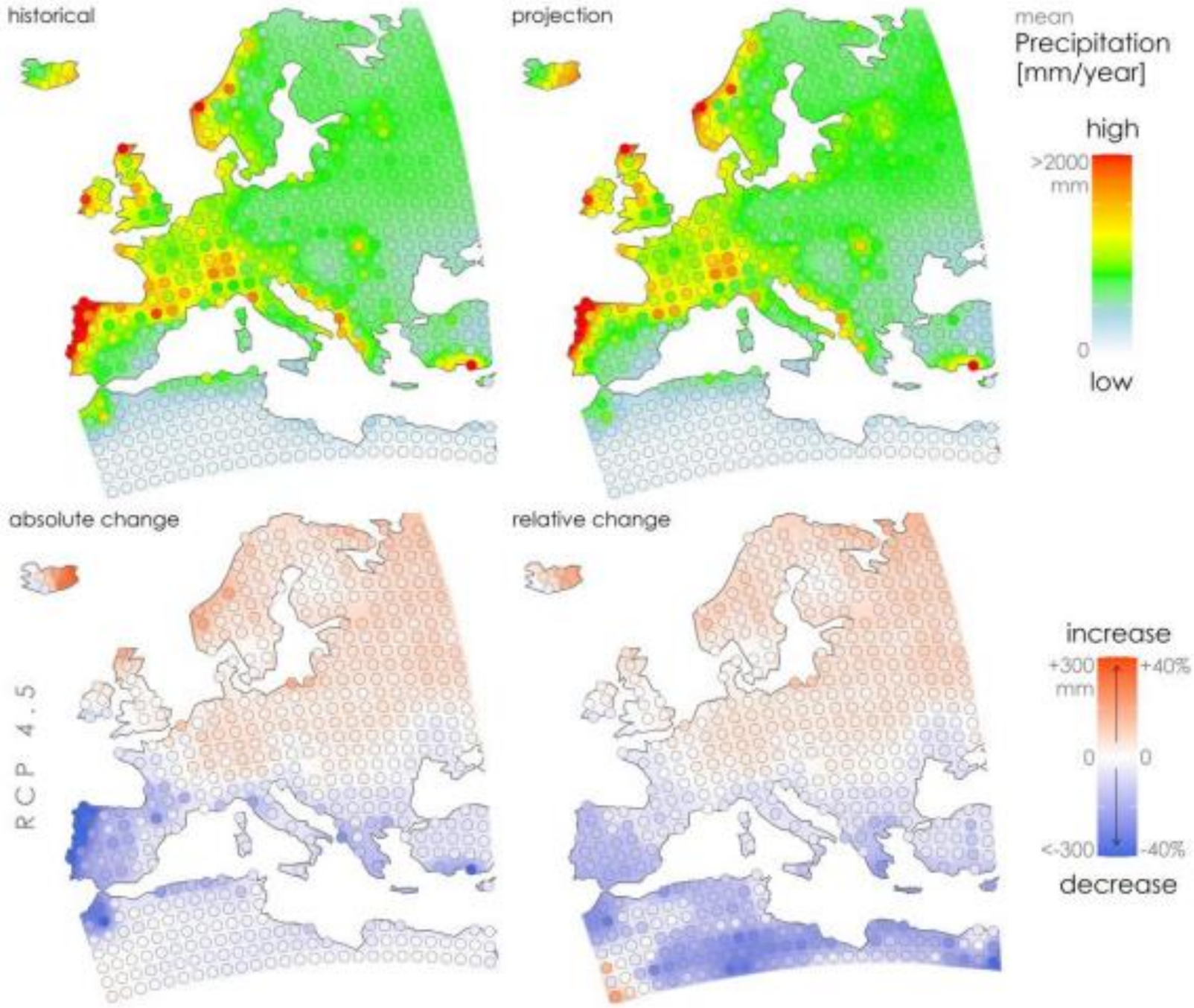
REGEN

Climate-based

Mean annual precipitation load

The precipitation is generally higher along the coast lines of the Atlantic Ocean, the Pyrenees, and the Alps, compared to the mainland and Mediterranean coastal region. The precipitation load varies considerably between grid points in the west of Europe due to seas and orographic features, whereas it is quite uniform in the east. The precipitation load is generally projected to increase in the mid-latitudes and high latitudes of Europe. A decrease is projected in the south of Europe and the Mediterranean.



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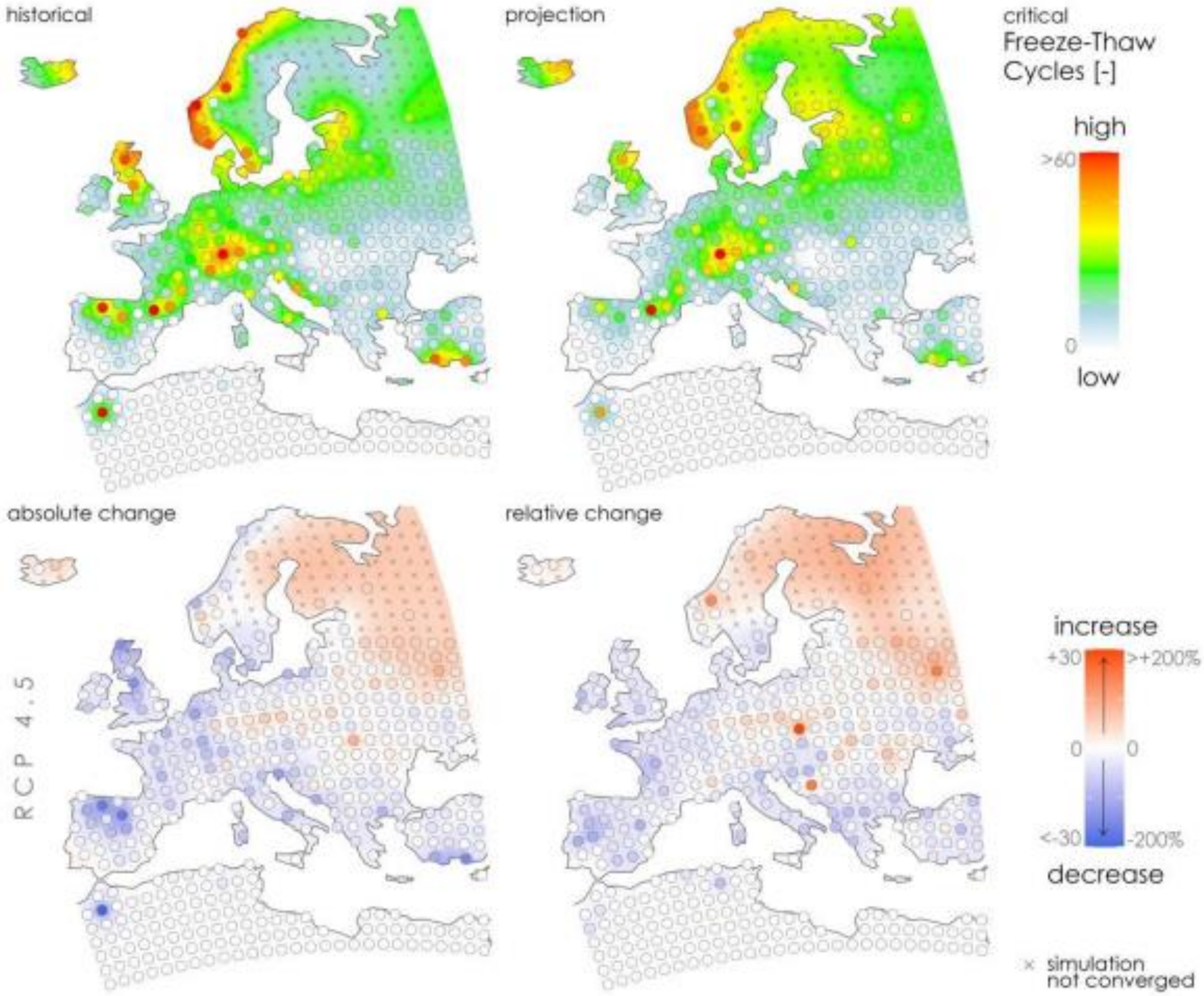
VORSTSCHADE

Response-based

Critical freeze-thaw cycles in insulated solid masonry walls of brick ZH

The risk for freeze-thaw damage is higher compared to the case without interior insulation. The same regions that are at risk for degradation are expanded compared to the previous case. Note that a large part of the simulations did not converge, especially in the north of the domain. The risk for degradation is generally projected to decrease in the west and south of the domain, and projected to increase in the centre and east of Europe. In the north, however, the change is unclear given the high number of not converged simulations. The maps illustrate an extrapolation between the available data, which



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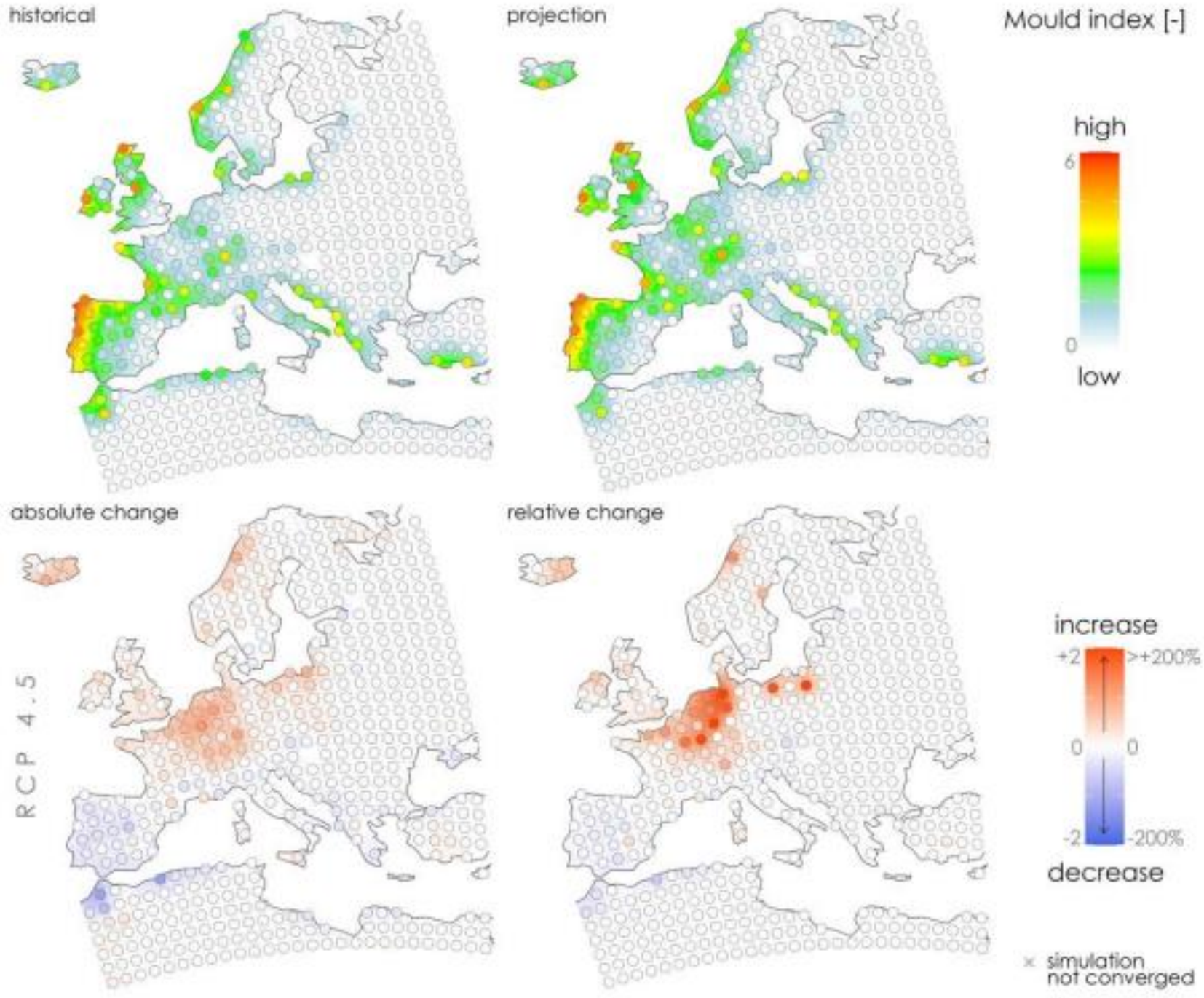
SCHIMMEL

Response-based

Mould growth in uninsulated solid masonry walls of brick ZH

Mould growth is usually only an issue at locations that receive a high wind-driven rain load. Though, the geographical pattern of changing mould index is different from the wind-driven rain load. In particular, there is an increase in mould index in the north of France, Belgium, the Netherlands, Luxembourg, and parts of Germany.



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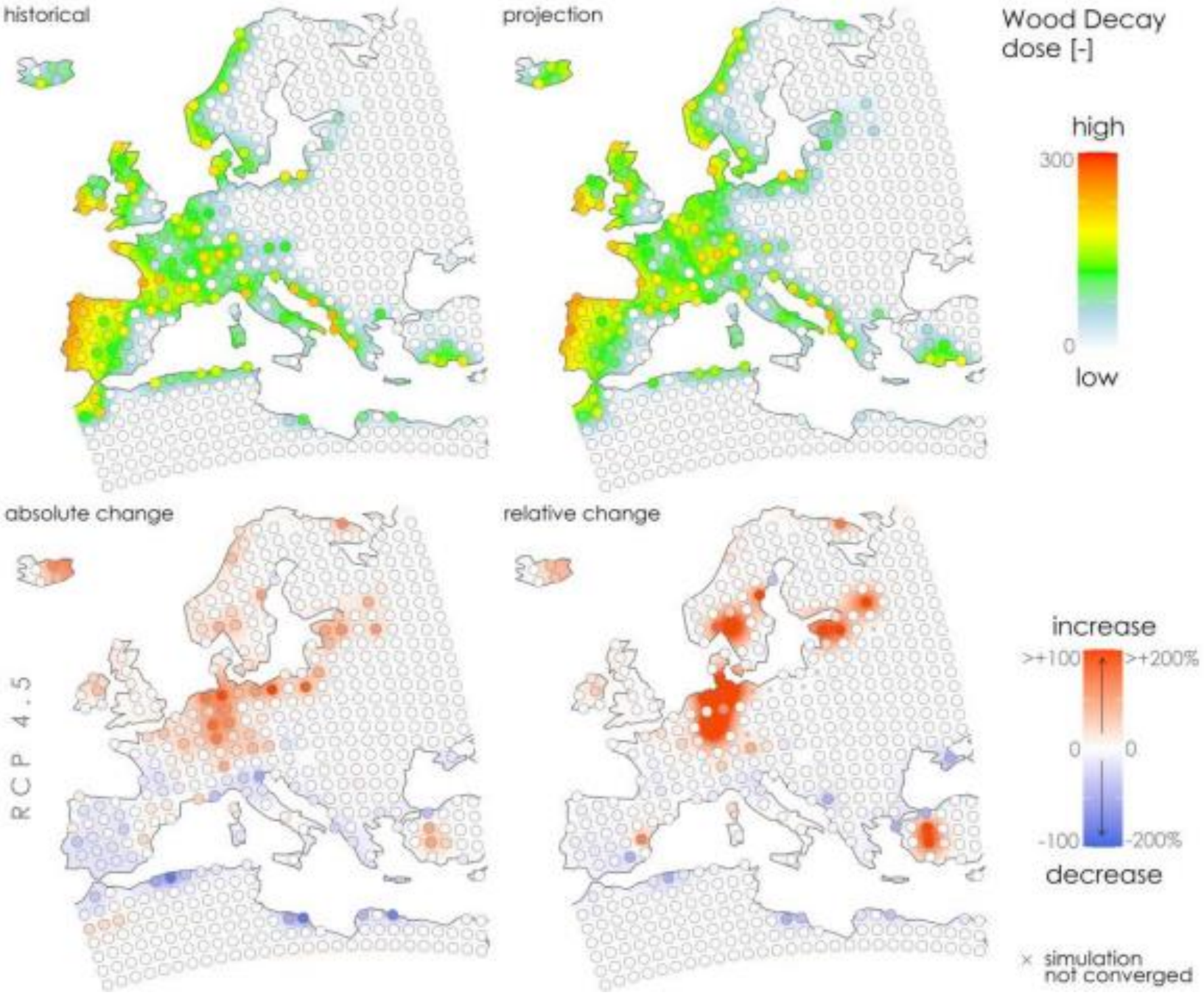
HOUTROT

Response-based

Wood decay in uninsulated solid masonry walls of brick ZK

The wood decay is higher for brick ZK compared to ZH. The regions that are at risk are similar to the regions with a high wind-driven rain load. Though, the wood decay dose is generally zero in the east of Europe, and south of the Mediterranean Sea, where wind-driven rain is low. The geographical spread of the change in wood decay dose is similar to the change in mould growth.



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- KLIMAATVERANDERING
- **IMPACT ENERGIEPRESTATIE**

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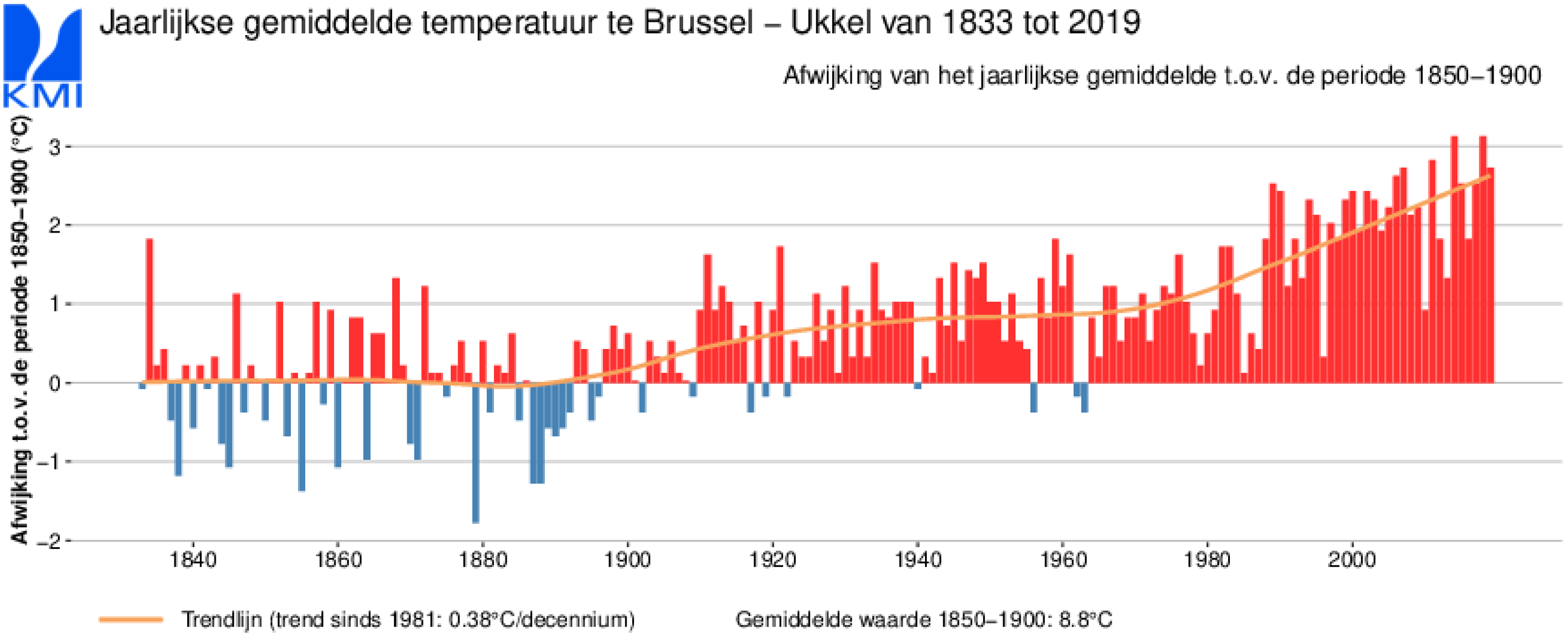
IMPACT OP VERWARMING & KOELING



3 maatregelenpakketten werden gedefinieerd

MP1	U-muur: 0.76W/m²K	geen ventilatie
	gas boiler	geen PV
MP2	U-muur: 0.24W/m²K	C systeem
	gas condens boiler	PV: 10 kWh/m²
MP3	U-muur: 0.15W/m²K	D systeem
	warmtepomp	PV: 15 kWh/m²

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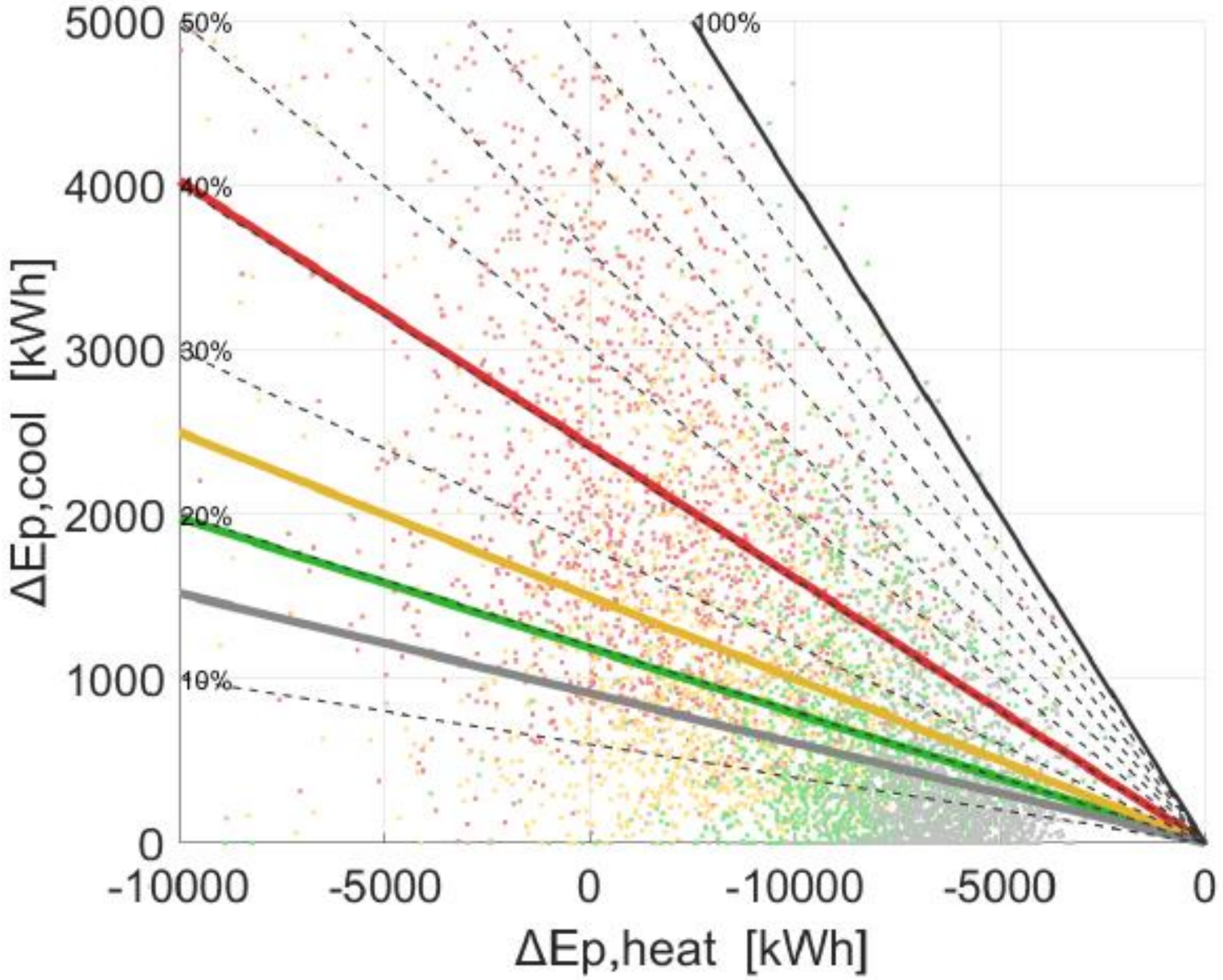
VERWARMING VS KOELING | MP2 | VRIJST.



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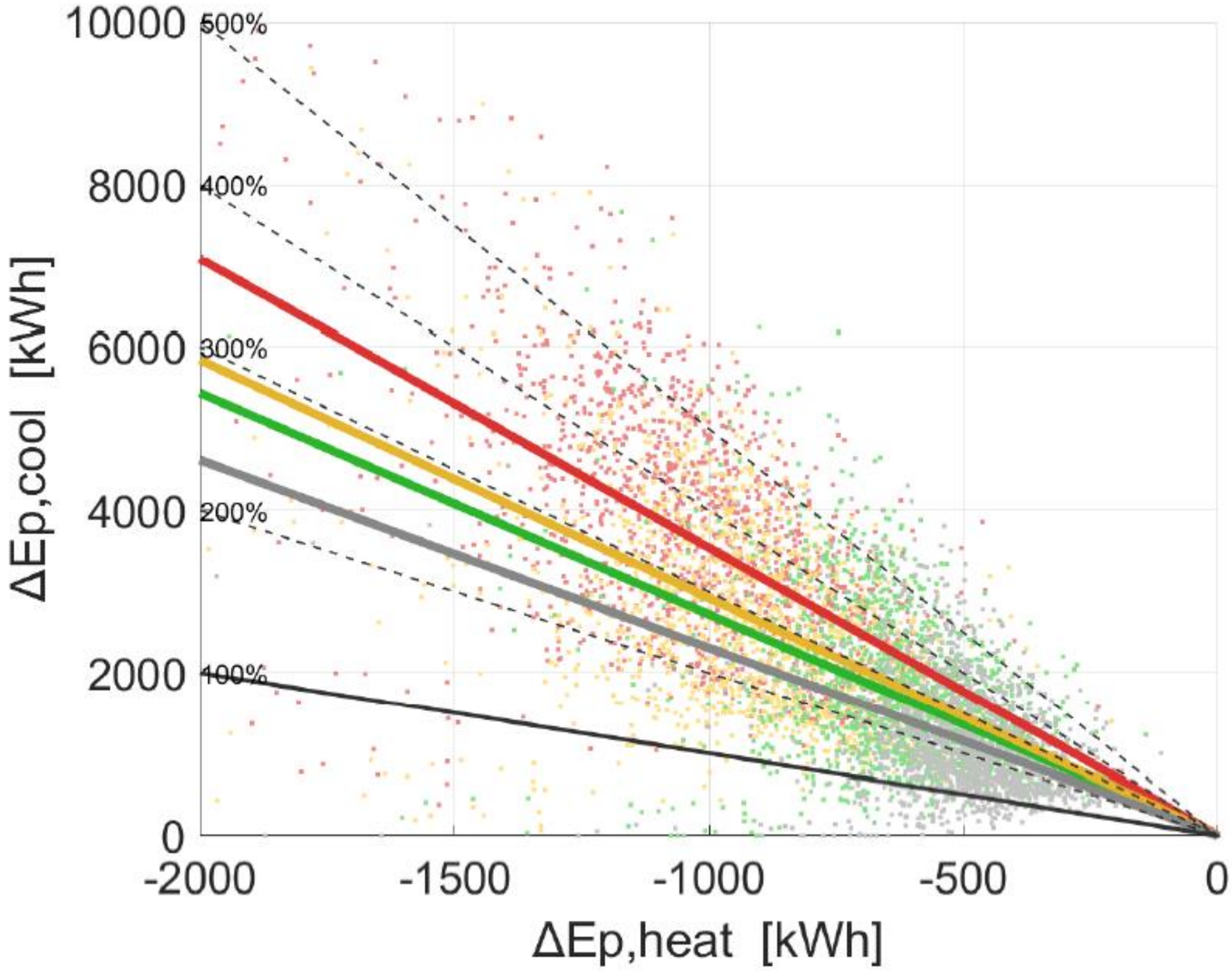
VERWARMING VS KOELING | MP3 | VRIJST.



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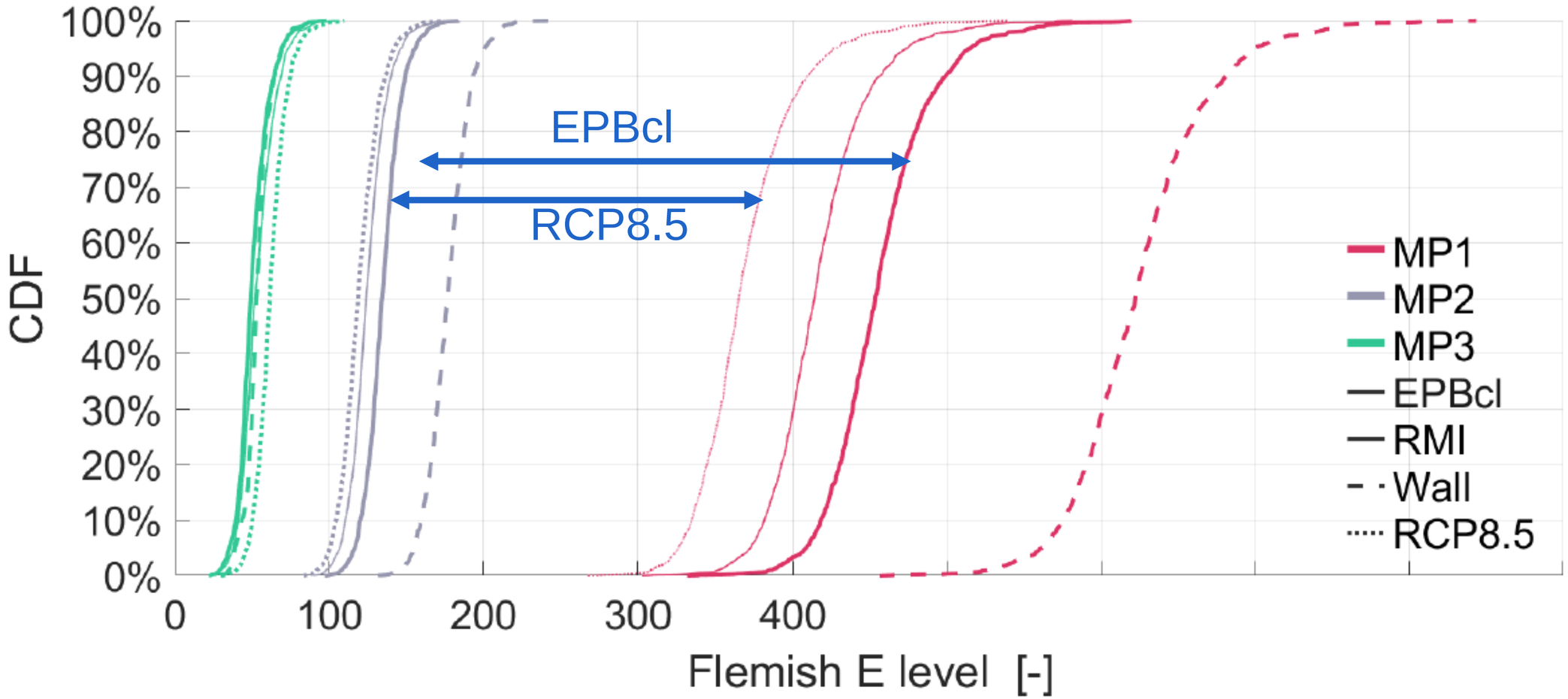
VERGELIJKING MAATREGELENPAKKETTEN VRIJSTAAND



- KLIMAATVERANDERING
- IMPACT ENERGIEPRESTATIE
- **WERKELIJK ENERGIEGEBRUIK**

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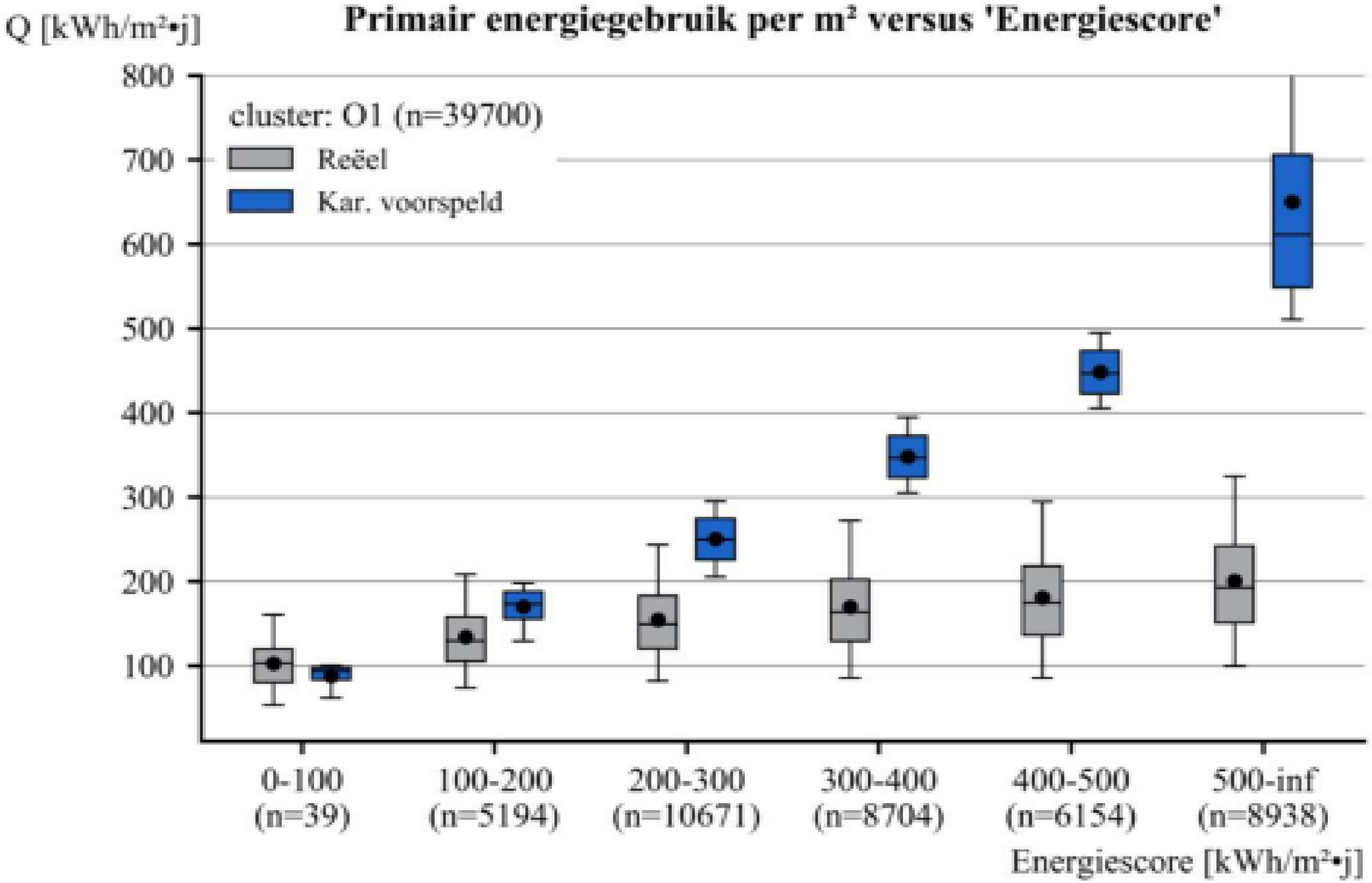
Energiebesparing



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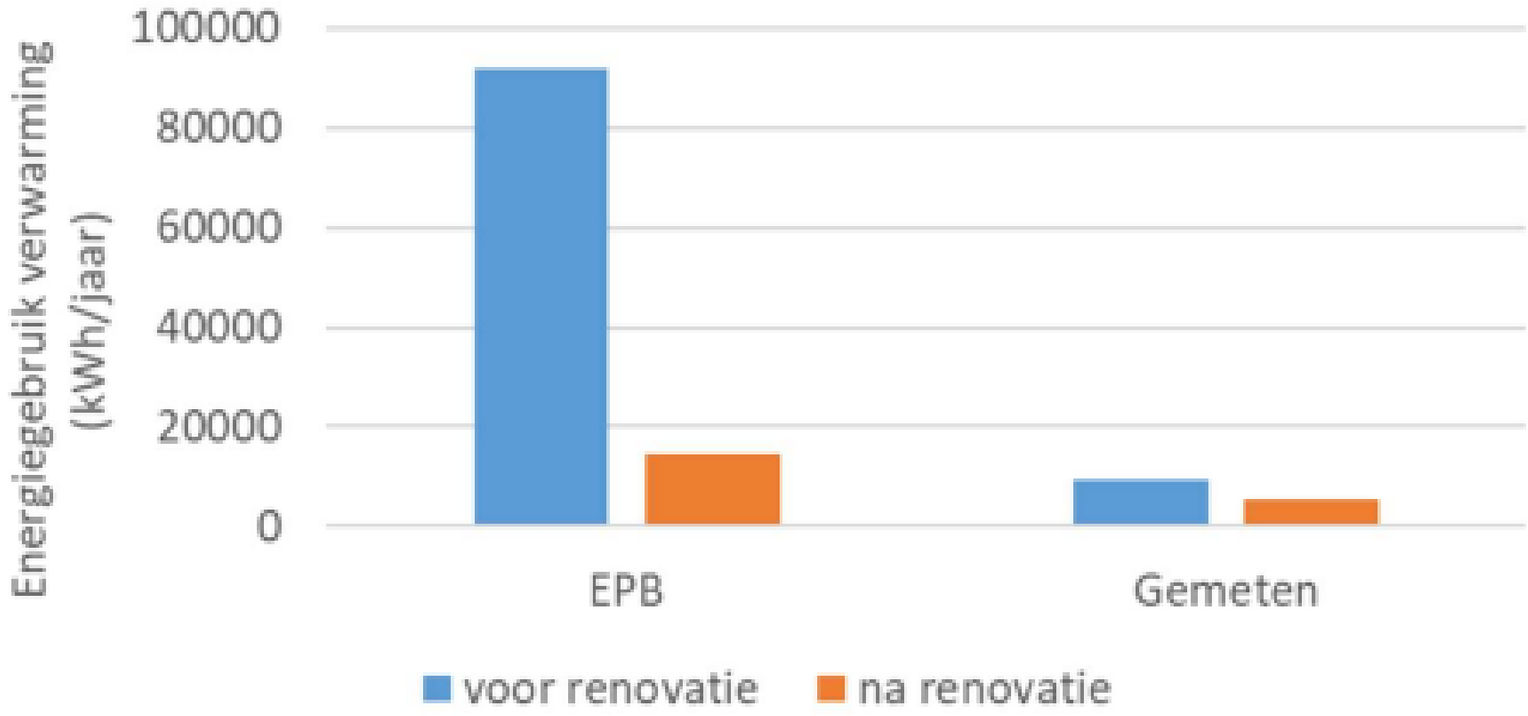
Energiebesparing

(a) Front facade, before renovation.

(b) Front facade, after renovation.



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Bron: Deurinck, 2015

- KLIMAATVERANDERING
- IMPACT ENERGIEPRESTATIE
- WERKELIJK ENERGIEGEBRUIK
- **LCA GLAS & SCHRIJNWERK**

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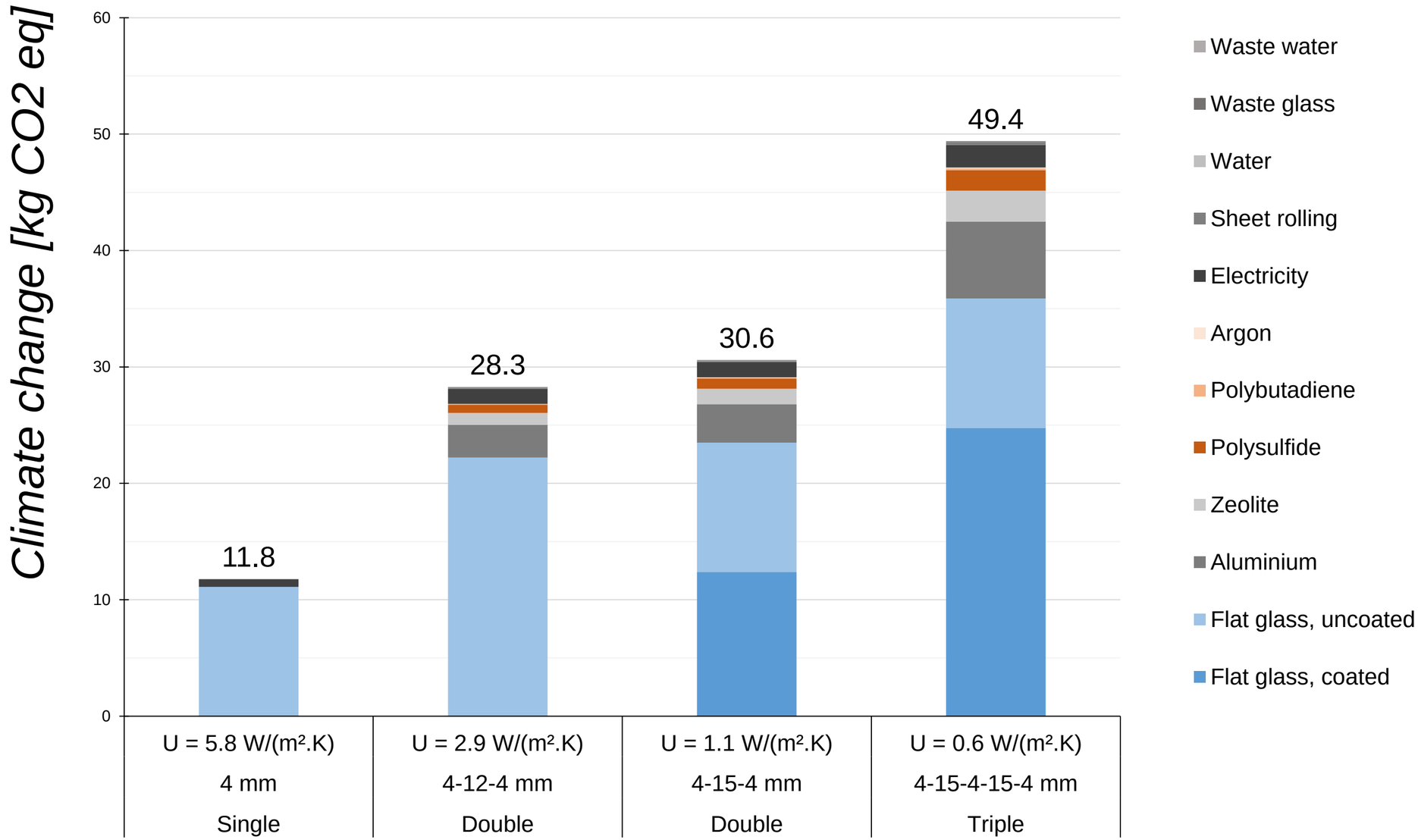
PRODUCTION OF 1 M² GLAZING



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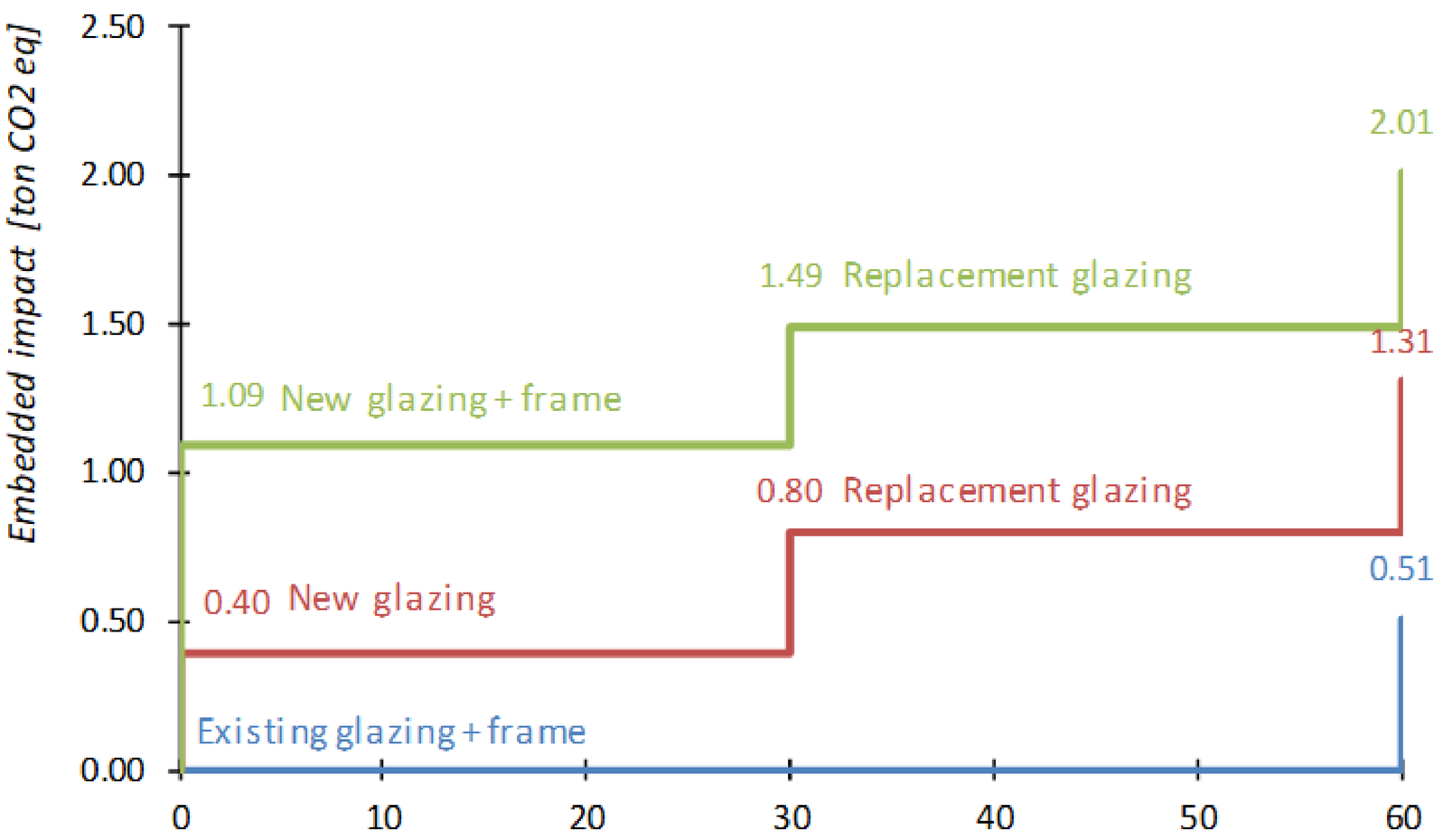
EMBEDDED IMPACT



Terraced dwelling

417 m³ protected volume

237 m² heat loss area

16 m² windows

20% window-to-wall area

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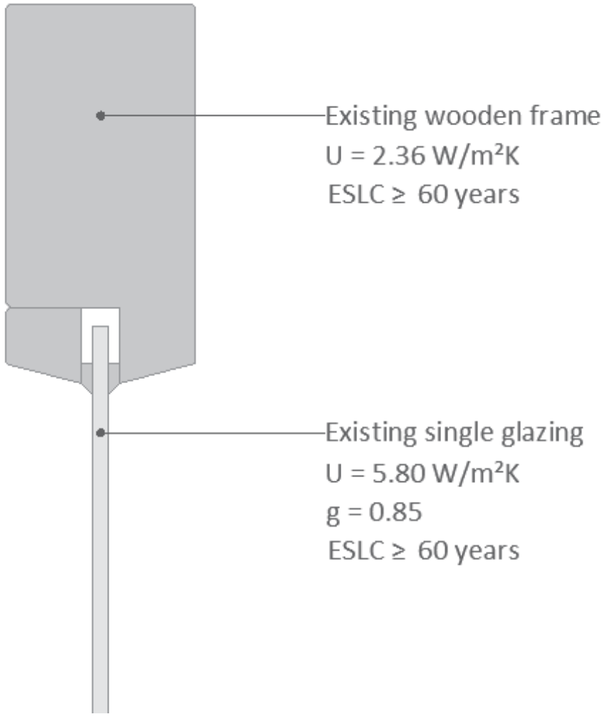
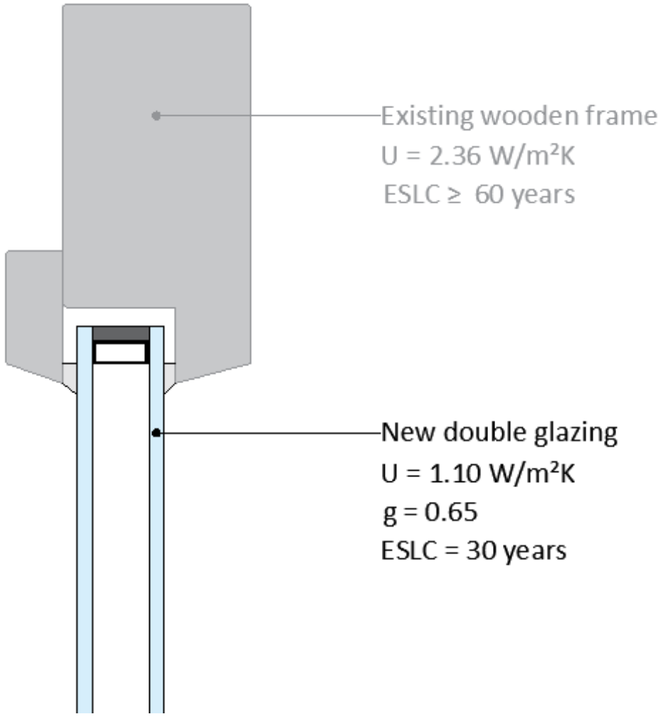
Uw = 4.94 W/(m².K)

*2.36 * 0.25 + 5.80 * 0.75 + 3 * 0.00*



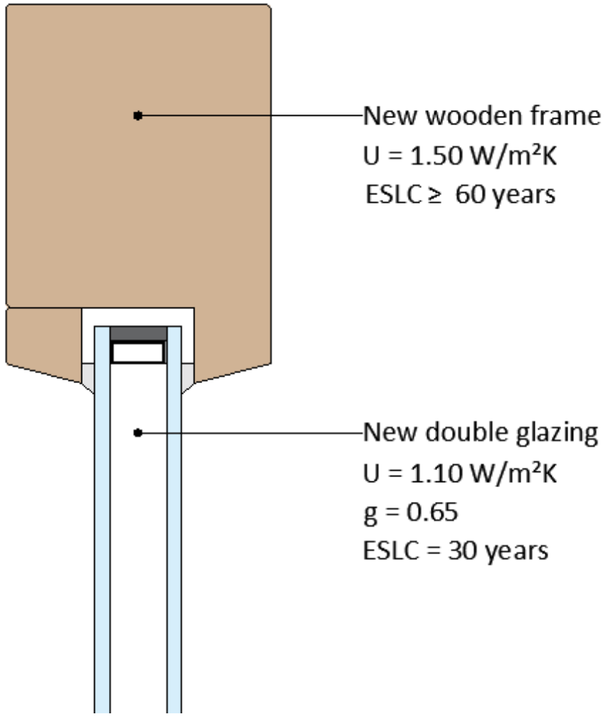
Uw = 1.66 W/(m².K)

*2.36 * 0.25 + 1.10 * 0.75 + 3 * 0.08*



Uw = 1.44 W/(m².K)

*1.50 * 0.25 + 1.10 * 0.75 + 3 * 0.08*



Initiële productie	**+ 0.40 ton CO2 eq**	**+ 1.09 ton CO2 eq**
Vervanging dubbele beglazing na 30 jaar	**+ 0.40 ton CO2 eq**	**+ 0.40 ton CO2 eq**
Eindelevensduurimpact	**+ 0.01 ton CO2 eq**	**+ 0.01 ton CO2 eq**
Operationele energie besparing per jaar	**- 0.95 ton CO2 eq**	**- 1.15 ton CO2 eq**
Terugverdientijd	**< 1 jaar**	**< 1 jaar**

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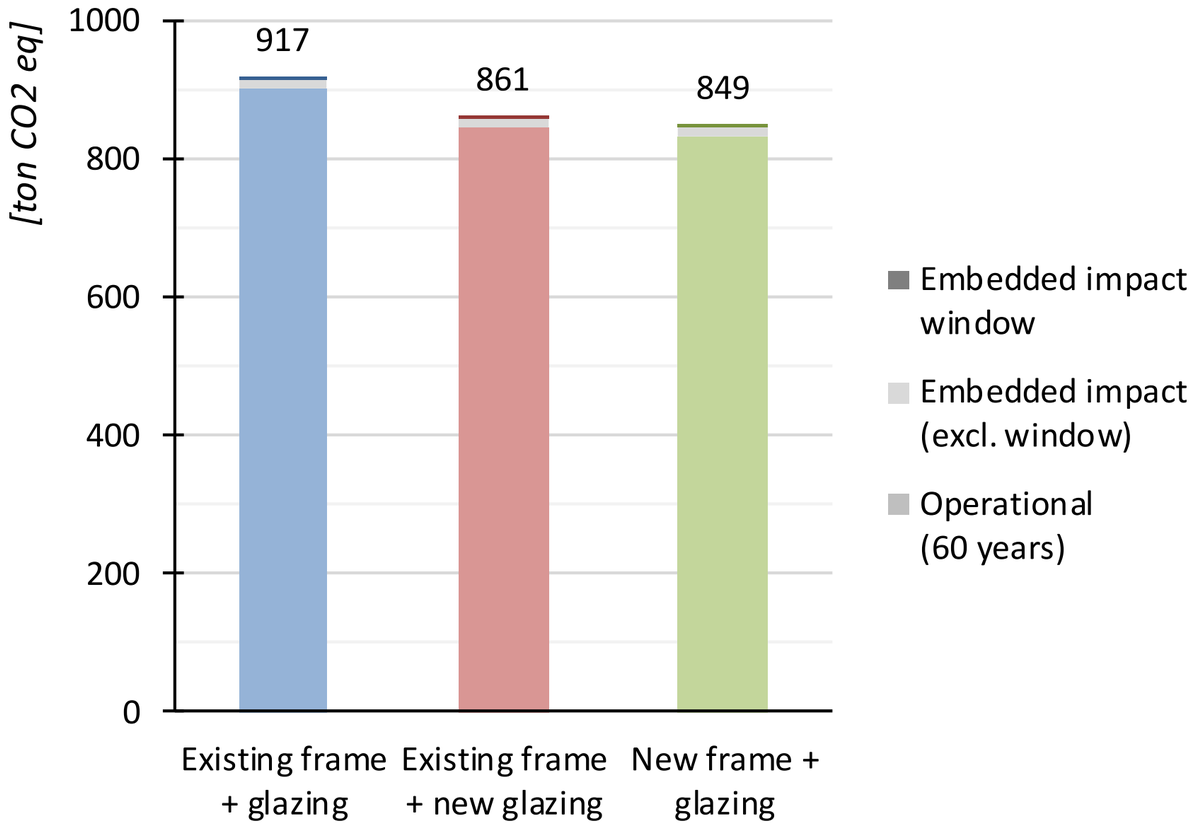
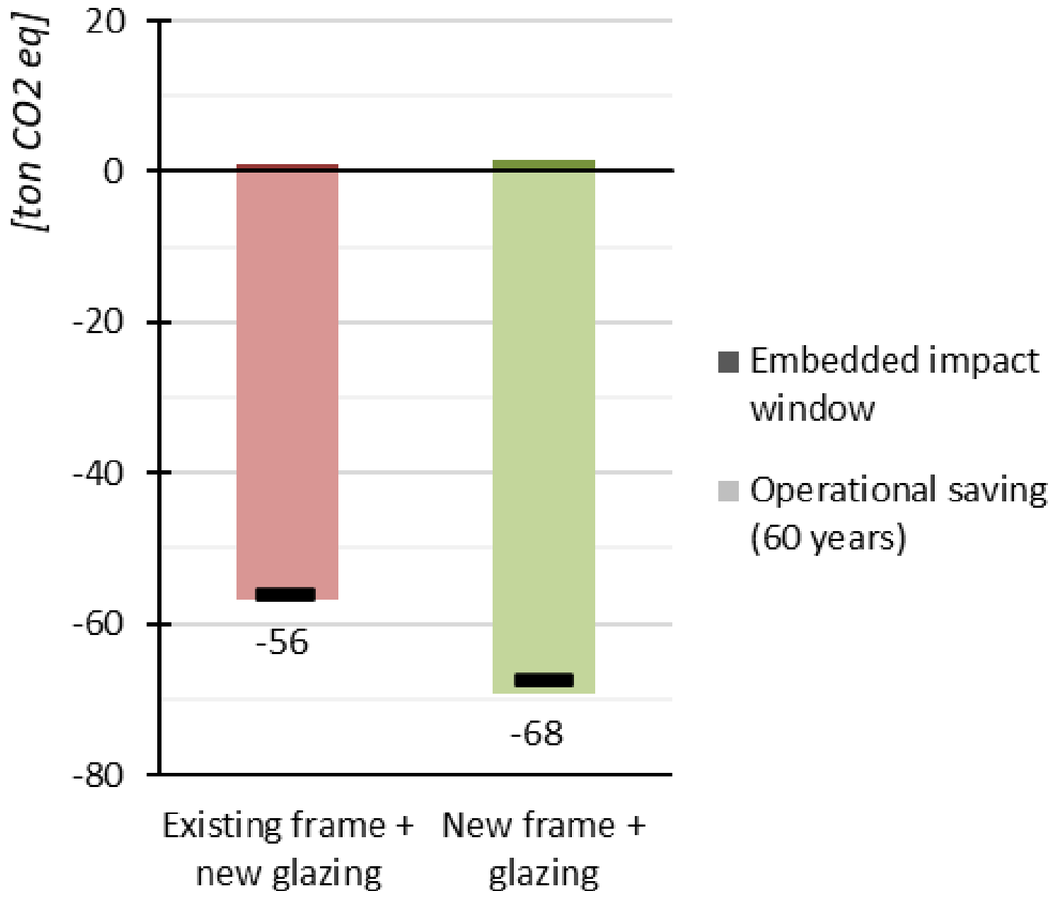
Building level

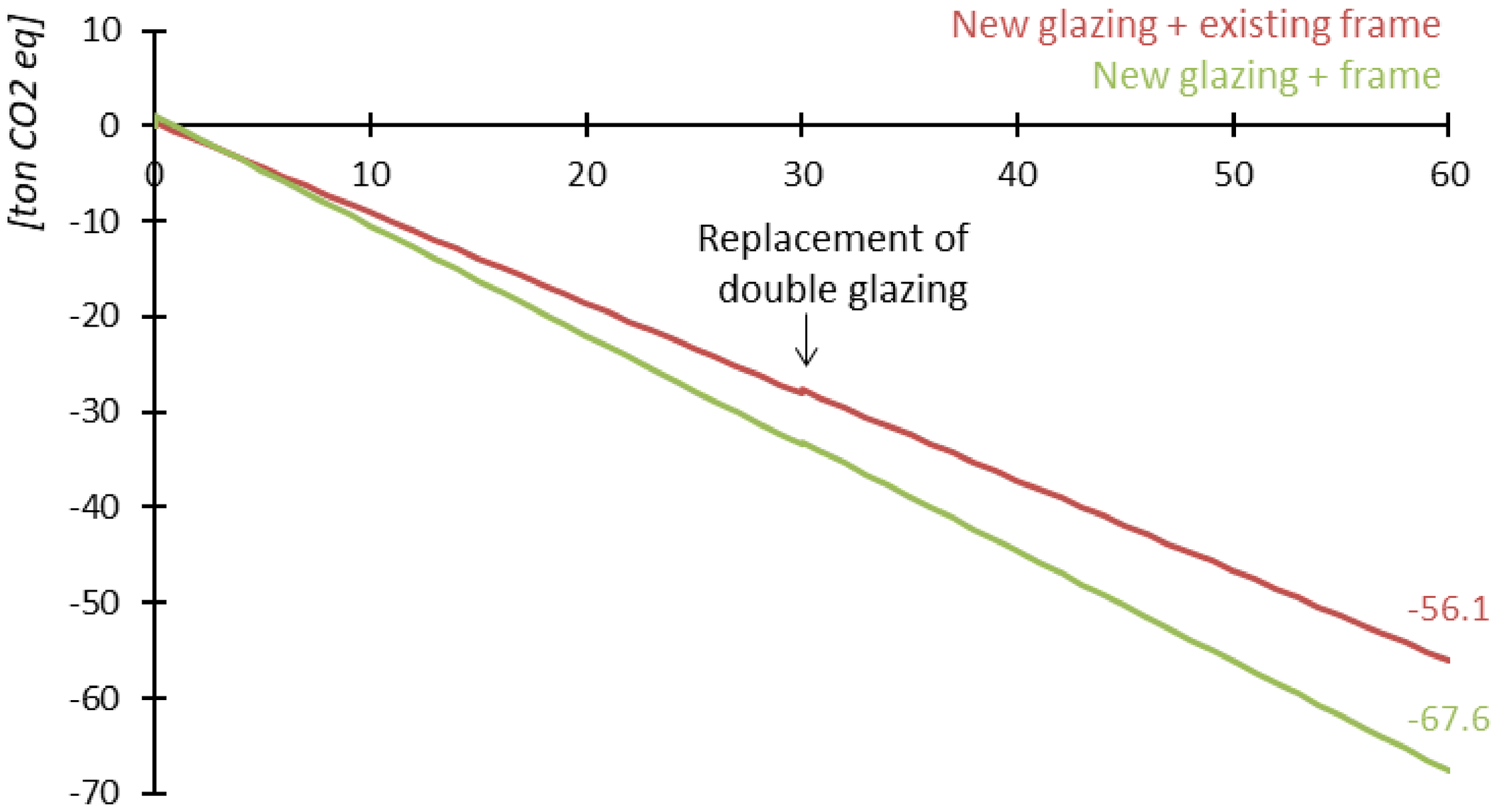


REF	-6.12%	-7.38%
6.52%	REF	-1.34%
7.97%	1.36%	REF

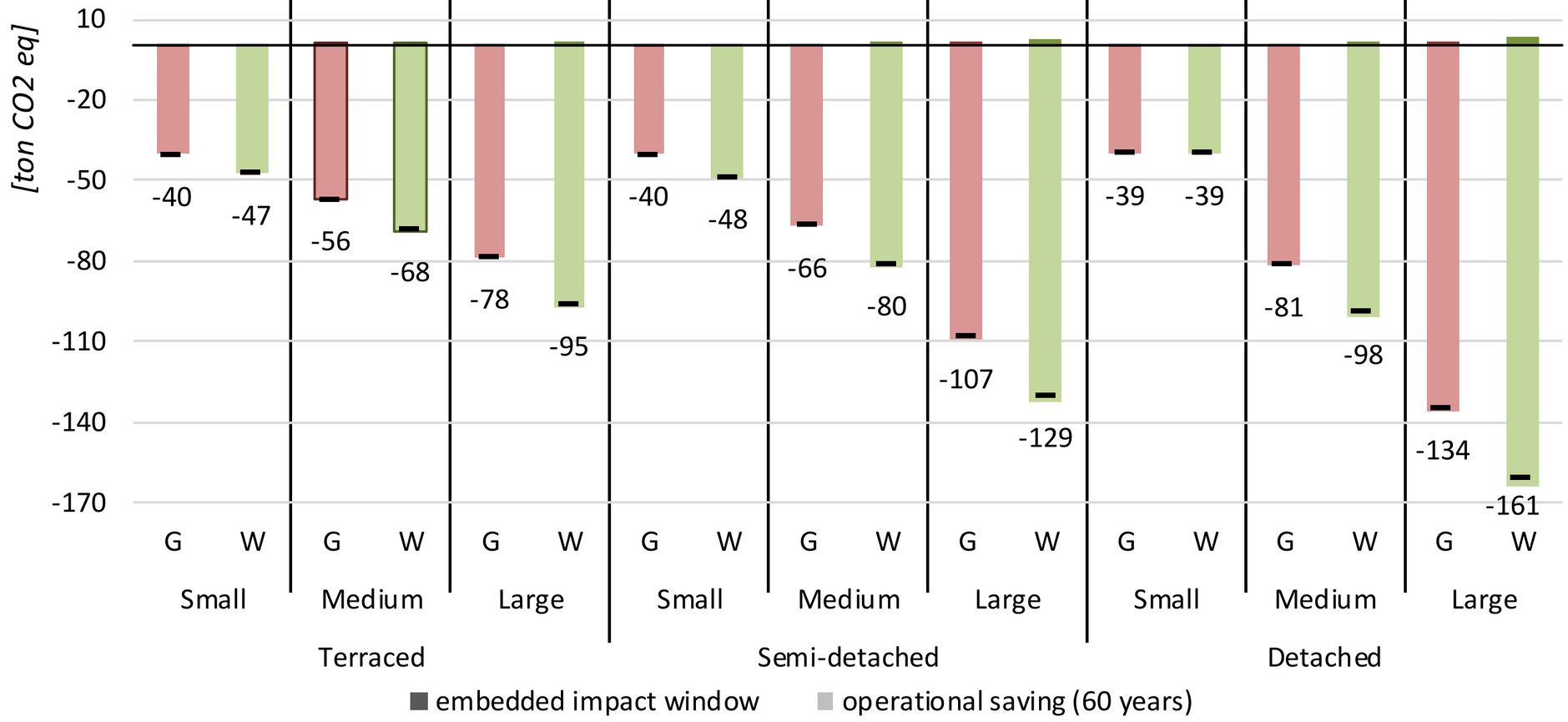
Net impact



Timeline net impact



Volume	[m³]	202	**417**	718	202	417	718	202	417	718
Heat loss area	[m²]	134	**237**	373	179	297	448	235	373	542
Window area	[m²]	11	**16**	23	11	19	30	11	23	38
Window-to-wall ratio	[%]	23%	**20%**	20%	13%	14%	16%	8%	11%	14%



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- KLIMAATVERANDERING
- IMPACT ENERGIEPRESTATIE
- WERKELIJK ENERGIEGEBRUIK
- LCA GLAS & SCHRIJNWERK
- **RENOVATIERITME**

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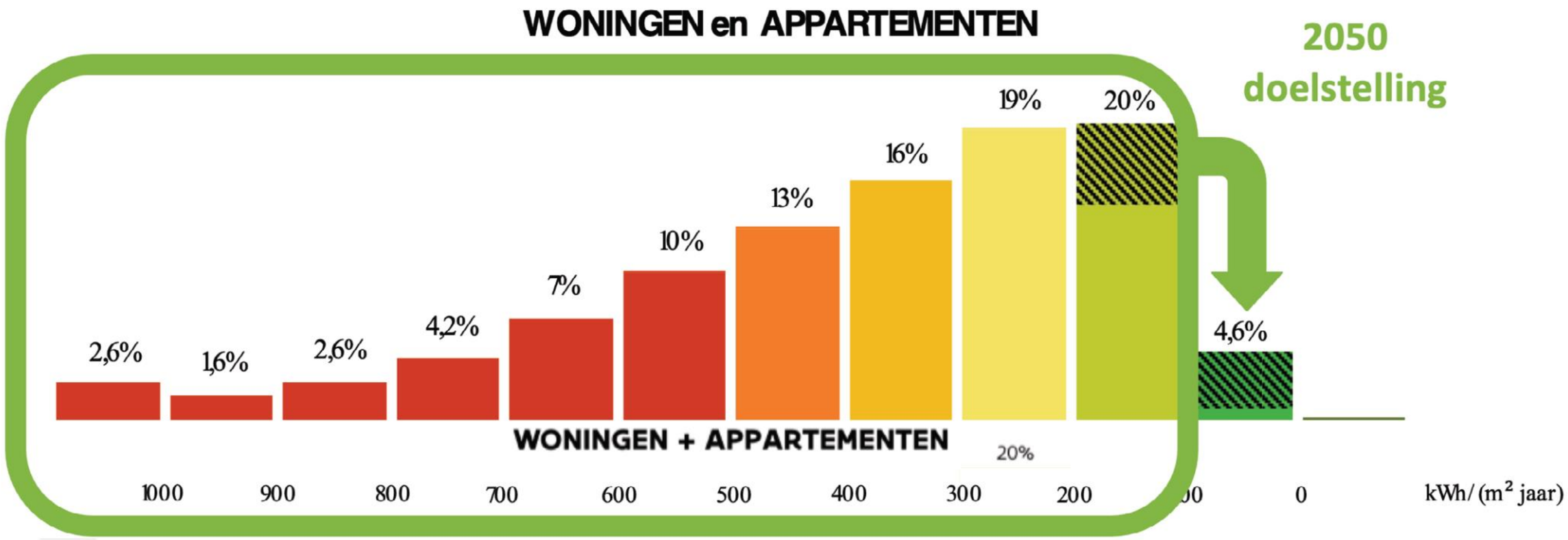

Figuur 1: Spreiding Vlaamse woningen over EPC-labels en de vooropgestelde ambitie voor 2050.
De gearceerde blokjes tonen de woningen die gebouwd werden na de introductie van de EPB-plicht in 2006. (januari 2021) [2]

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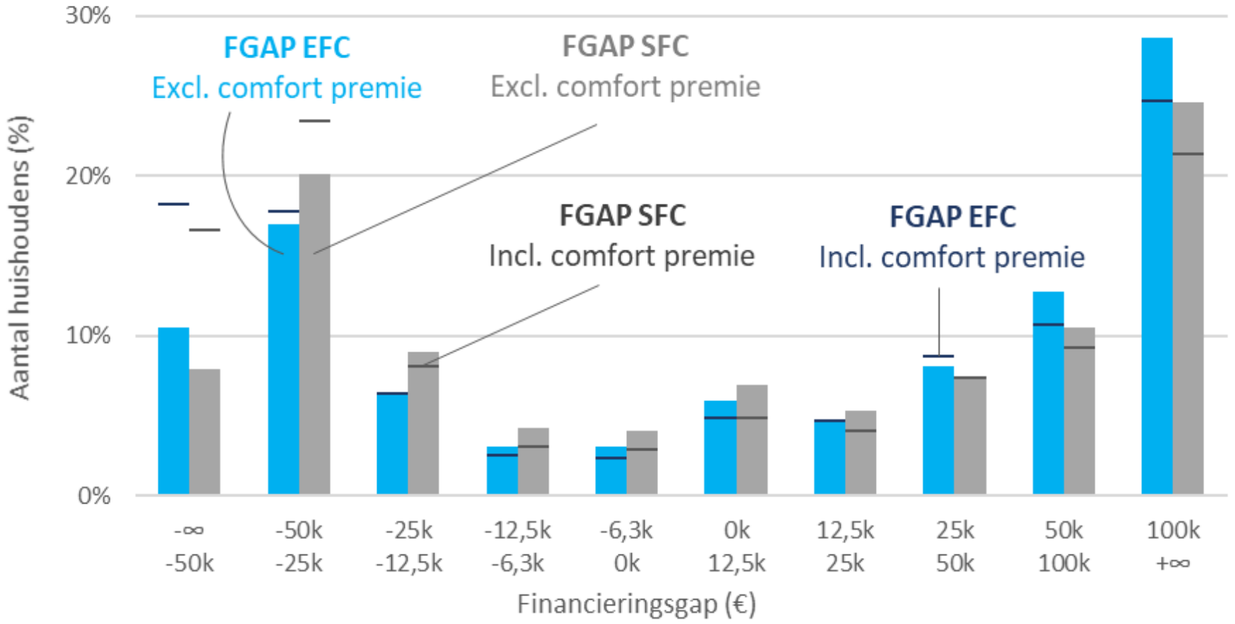
UW HUIS TOT DE HOOGSTE ENERGIEWAARDE OPTILLEN KAN TOT 125.000 EURO KOSTEN

	Tweegevelwoning				Driegevelwoning				Vrijstaande woning			
	EPC-label	EPC-kencijfer	Kost per ingreep (in €)	**Opgetelde kosten (in €)**	EPC-label	EPC-kencijfer	Kost per ingreep (in €)	**Opgetelde kosten (in €)**	EPC-label	EPC-kencijfer	Kost per ingreep (in €)	**Opgetelde kosten (in €)**
Vertrekpunt van de woning	E	495	0	**0**	F	624	0	**0**	F	882	0	**0**
Dakisolatie (22cm MW)	D	365	+8.500 =	**8.500**	F	522	+8.500 =	**8.500**	F	775	+8.500 =	**8.500**
Buitenschrijnwerk (Uf=1,5 Ug=1,0)	D	339	+15.000 =	**23.500**	E	493	+16.500 =	**25.000**	F	728	+16.500 =	**25.000**
Condensatieketel	C	214	+7.500 =	**31.000**	D	302	+7.500 =	**32.500**	E	423	+7.500 =	**32.500**
Isolatie buitenmuren langs buitenzijde	B	123	+25.000 =	**56.000**	B	125	+36.000 =	**68.500**	B	147	+42.000 =	**74.500**
Isolatie vloeren (80mmPU)	B	105	+9.000 =	**65.000**	B	105	+9.000 =	**77.500**	B	130	+9.000 =	**83.500**
Ventilatie systeem C + vraagsturing	A	96	+5.000 =	**70.000**	A	98	+5.000 =	**82.500**	B	119	+5.000 =	**88.500**
Ventilatie systeem D + warmterecuperatie	A	88	+5.000 =	**75.000**	A	88	+5.000 =	**87.500**	B	108	+5.000 =	**93.500**
Warmtepomp (Lucht/water)	A	72	+10.000 =	**85.000**	A	76	+10.000 =	**97.500**	A	94	+10.000 =	**103.500**
Warmtepomp (Bodem/water)			-		A	68	+11.000 =	**108.500**	A	84	+11.000 =	**114.500**
Zonnepanelen (3kWp zuidgericht)	A	21	+6.000 =	**91.000**	A	20	+6.000 =	**114.500**	A	45	+6.000 =	**120.500**
Zonnepanelen (4,5kWp zuidgericht)	A+	-3	+2.000 =	**93.000**	A+	-4	+2.000 =	**116.500**	A+	-3	+4.000 =	**124.500**

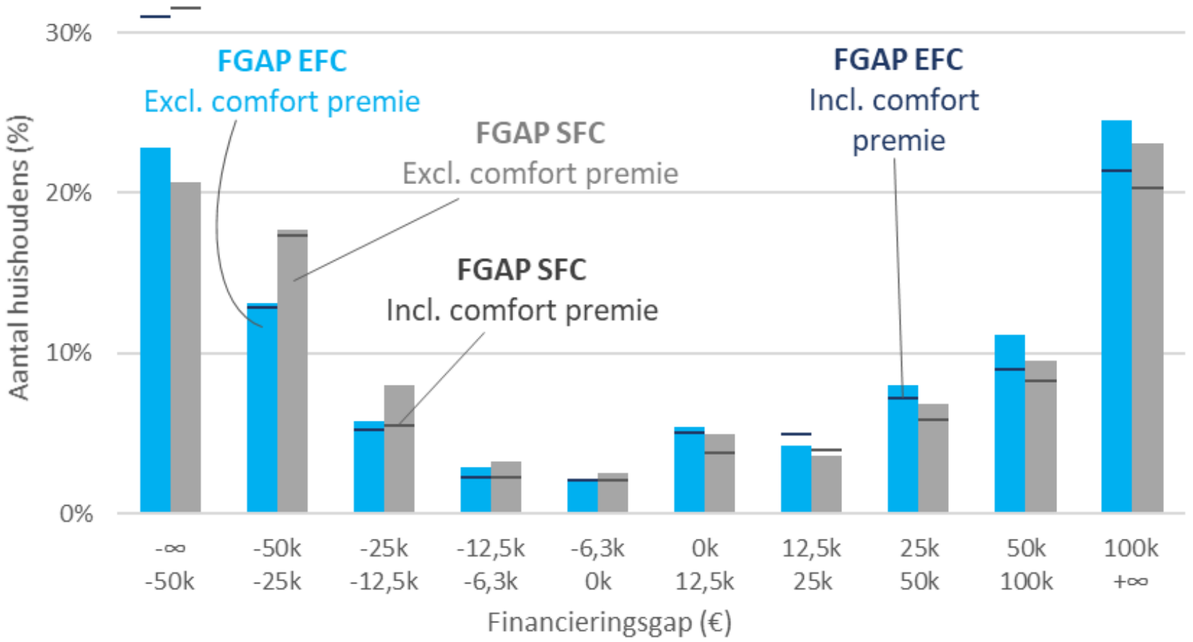
Bron: Vlaamse Confederatie Bouw (VCB). Simulatie gebaseerd op de prijzen die het Vlaams Energie- en Klimaatagentschap voor de EPC-documenten van januari 2022 hanteerde.

UPDATE

Rente 1,5%



Rente 3,5%
inkomens 6% hoger door indexaties
renovatiekost 33% hoger



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ITINERA
Expertise - Pathways - Impact

RENOVATIERITME - VOORSPELLINGEN

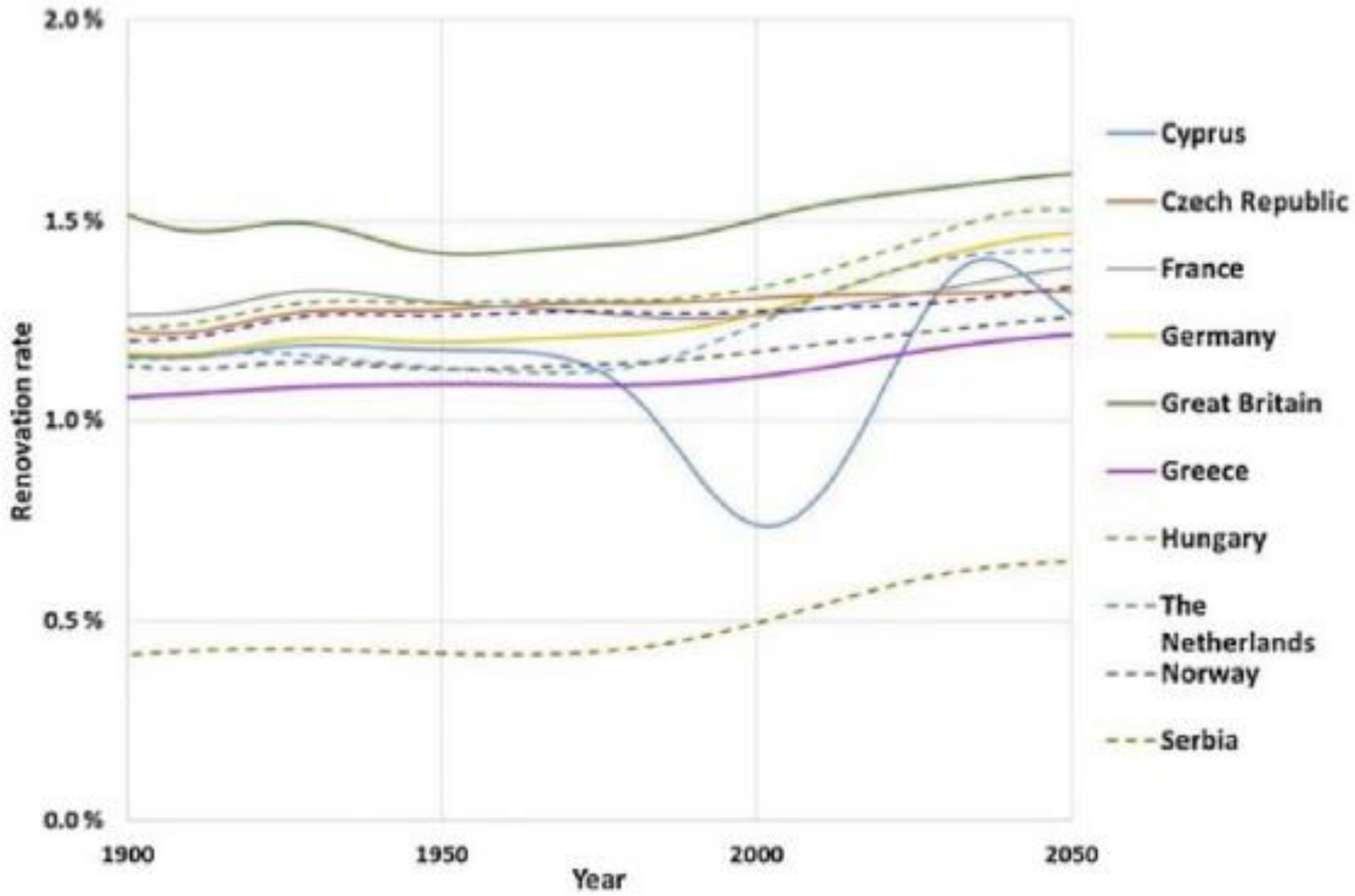

Figure 1 – Simulated renovation rates in various countries from 1900 till 2050 (Sandberg et al., 2016)

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Bedankt voor uw aandacht

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