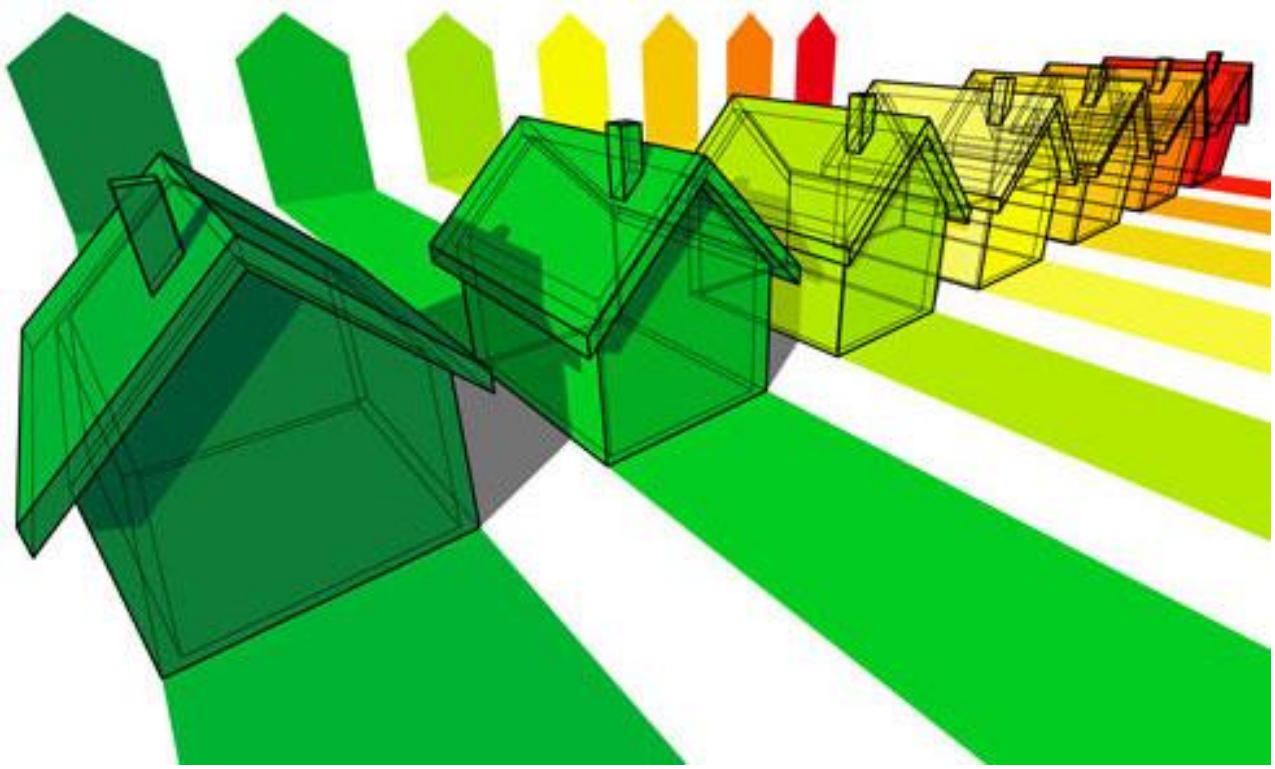


Energy Performance Certificate – experiments on information framing

UHASSELT
KNOWLEDGE IN ACTION

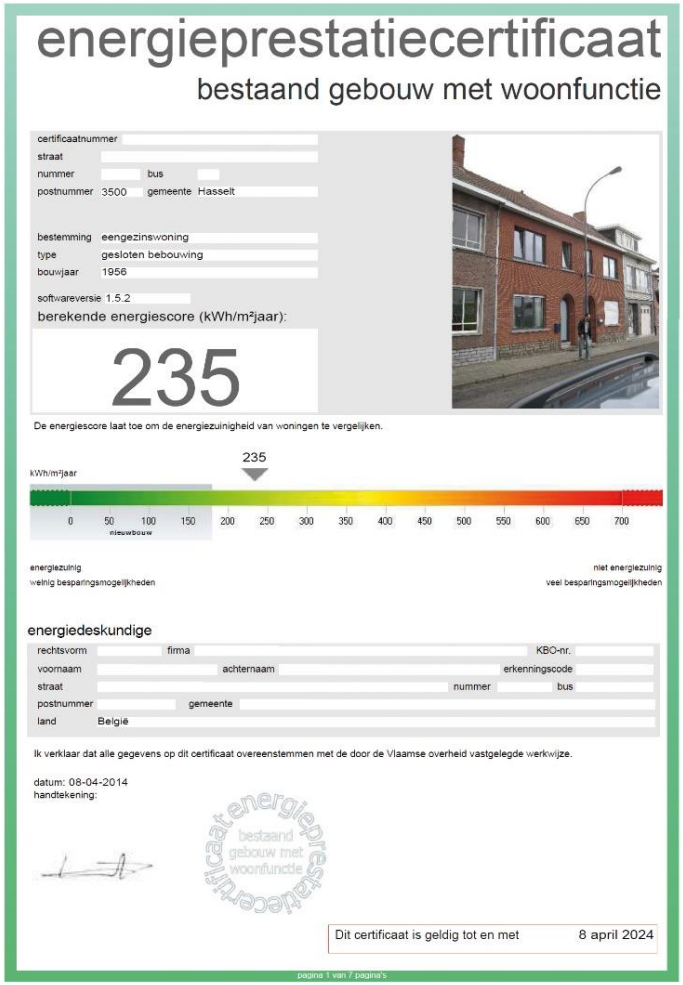
Victoria Taranu
Adviser Prof. dr. ir. arch. Griet Verbeeck

Energy performance certificate EPC

UHASSELT

Energy Performance Certificate (EPC)

- Mandatory for all EU member states
  - At the moment of selling or renting out the property
- Purpose: compare dwellings in terms of energy performance
- Standard occupancy
  - The certificate does not reflect user patterns



energieprestatiecertificaat

bestaand gebouw met woonfunctie

certificaatnummer
straat
nummer bus
postnummer 3500 gemeente Hasselt

bestemming eengezinswoning
type gesloten bebouwing
bouwjaar 1956

softwareversie 1.5.2

berekende energiescore (kWh/m²jaar):

235

De energiescore laat toe om de energiezuinigheid van woningen te vergelijken.

235

kWh/m²jaar

0 50 100 150 200 250 300 350 400 450 500 550 600 650 700

nieuwbouw

energiezuinig
weinig besparingsmogelijkheden

niet energiezuinig
veel besparingsmogelijkheden

energiedeskundige

rechtsvorm firma KBO-nr.
voornaam achternaam erkenningscode
straat nummer bus
postnummer gemeente
land België

Ik verklaar dat alle gegevens op dit certificaat overeenstemmen met de door de Vlaamse overheid vastgelegde werkwijze.

datum: 08-04-2014
handtekening:

energieprestatiecertificaat bestaand gebouw met woonfunctie

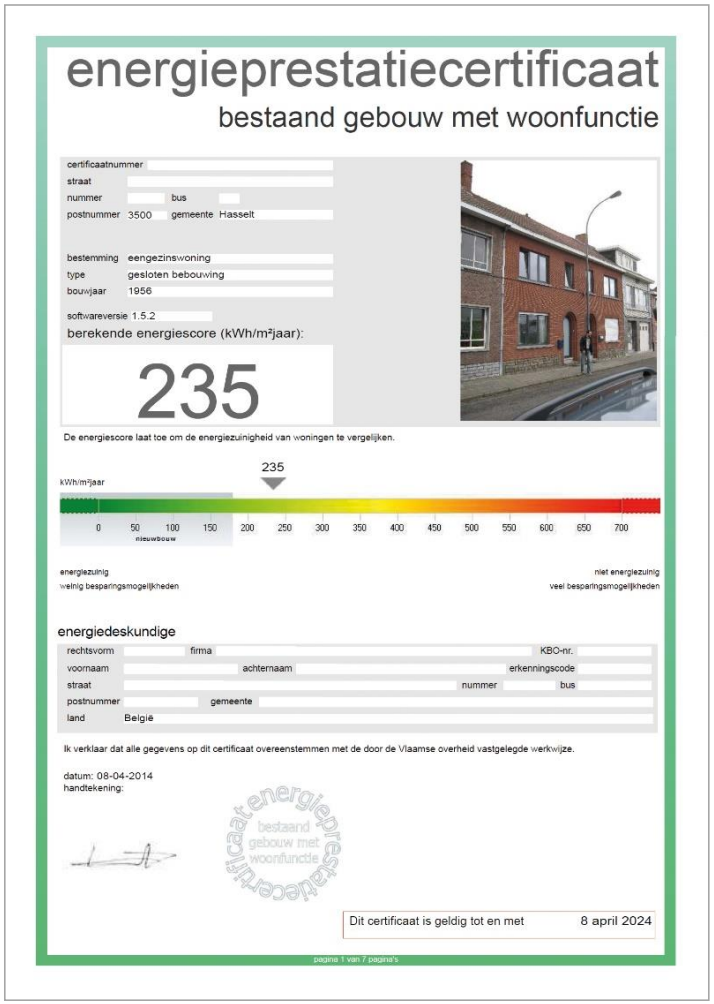
Dit certificaat is geldig tot en met 8 april 2024

pagina 1 van 7 pagina's

EPC Flanders

UHASSELT
KNOWLEDGE IN ACTION

Flemish EPC – collaboration with the Energy Agency VEA



energieprestatiecertificaat

bestaand gebouw met woonfunctie

certificaatnummer
straat
nummer bus
postnummer 3500 gemeente Hasselt

bestemming eengezinswoning
type gesloten bebouwing
bouwjaar 1956

softwareversie 1.5.2

berekende energiescore (kWh/m²jaar):

235

De energiescore laat toe om de energiezuinigheid van woningen te vergelijken.

235

kWh/m²jaar

0 50 100 150 200 250 300 350 400 450 500 550 600 650 700

nieuwbouw

energiezuinig
weinig besparingsmogelijkheden

niet energiezuinig
veel besparingsmogelijkheden

energiedeskundige

rechtsvorm firma KBO-nr.
voornaam achternaam erkenningscode
straat nummer bus
postnummer gemeente
land België

Ik verklaar dat alle gegevens op dit certificaat overeenstemmen met de door de Vlaamse overheid vastgelegde werkwijze.

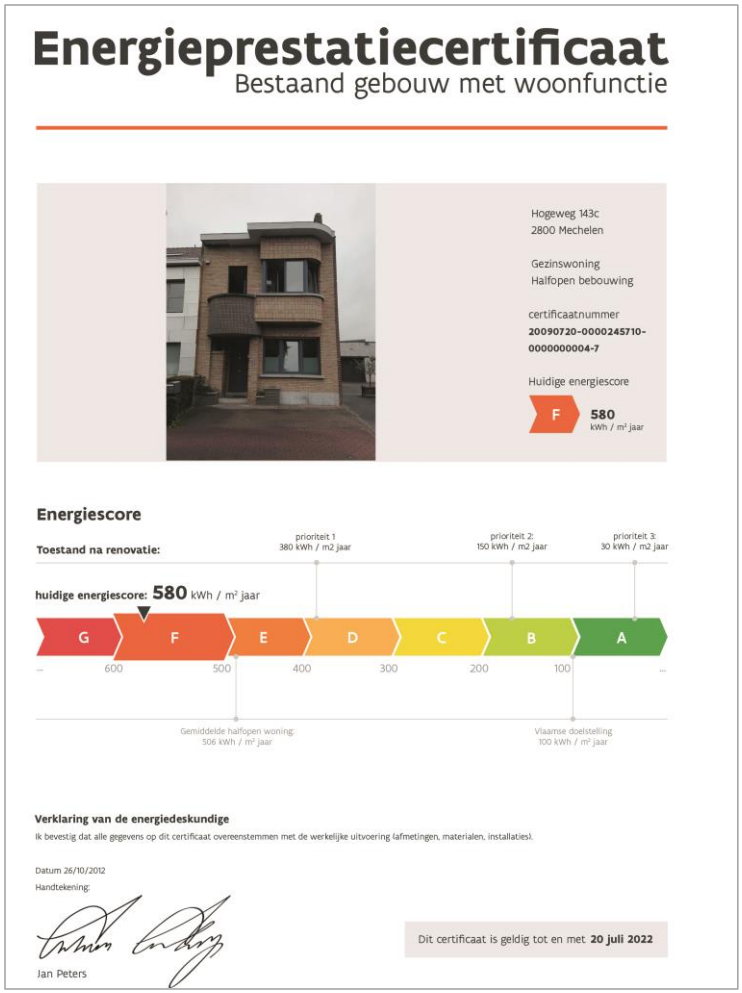
datum: 08-04-2014
handtekening:

energieprestatiecertificaat bestaand gebouw met woonfunctie

Dit certificaat is geldig tot en met 8 april 2024

pagina 1 van 7 pagina's

Existing version



Energieprestatiecertificaat

Bestaand gebouw met woonfunctie

Hogeweg 143c
2800 Mechelen

Gezinswoning
Halfopen bebouwing

certificaatnummer
20090720-0000245710-0000000004-7

Huidige energiescore

F **580** kWh / m² jaar

Energiescore

Toestand na renovatie:

prioriteit 1: 380 kWh / m2 jaar
prioriteit 2: 150 kWh / m2 jaar
prioriteit 3: 30 kWh / m2 jaar

huidige energiescore: 580 kWh / m² jaar

G F E D C B A

... 600 500 400 300 200 100 ...

Gemiddelde halfopen woning: 506 kWh / m² jaar

Vlaamse doelstelling 100 kWh / m² jaar

Verklaring van de energiedeskundige

Ik bevestig dat alle gegevens op dit certificaat overeenstemmen met de werkelijke uitvoering (afmetingen, materialen, installaties).

Datum 26/10/2012
Handtekening:

Jan Peters

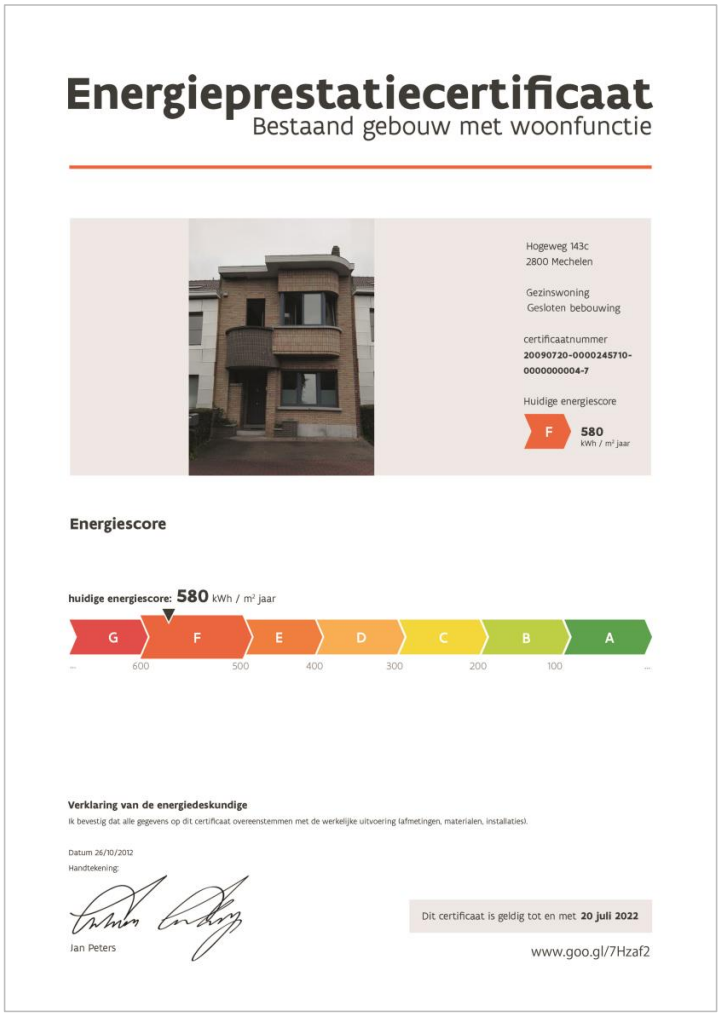
Dit certificaat is geldig tot en met **20 juli 2022**

New version VEA (preliminary August 2017)

UHASSELT
KNOWLEDGE IN ACTION

Flemish EPC – preliminary version

- Energy label (E)



Energieprestatiecertificaat

Bestaand gebouw met woonfunctie

Hogeweg 143c
2800 Mechelen

Gezinswoning
Gesloten bebouwing

certificaatnummer
20090720-0000245710-0000000004-7

Huidige energiescore

F **580** kWh / m² jaar

Energiescore

huidige energiescore: 580 kWh / m² jaar

G | F | E | D | C | B | A

600 500 400 300 200 100

Verklaring van de energiedeskundige

Ik bevestig dat alle gegevens op dit certificaat overeenstemmen met de werkelijke uitvoering (afmetingen, materialen, installaties).

Datum 26/10/2012

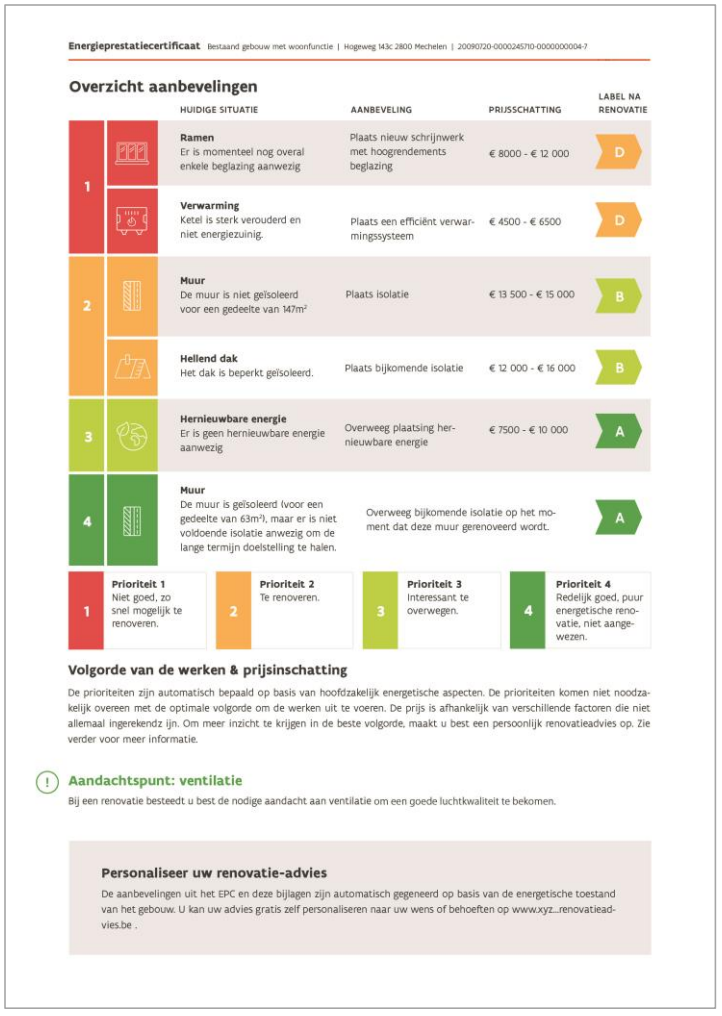
Handtekening:

Jan Peters

Dit certificaat is geldig tot en met **20 juli 2022**

www.goo.gl/7Hzaf2

- Recommendations (R)



Energieprestatiecertificaat Bestaand gebouw met woonfunctie | Hogeweg 143c 2800 Mechelen | 20090720-0000245710-0000000004-7

Overzicht aanbevelingen

	HUIDIGE SITUATIE	AANBEVELING	PRIJSSCHATTING	LABEL NA RENOVATIE
1	**Ramen** Er is momenteel nog overal enkele beglazing aanwezig	Plaats nieuw schrijnwerk met hoogrendements beglazing	€ 8000 - € 12 000	D
1	**Verwarming** Ketel is sterk verouderd en niet energiezuinig.	Plaats een efficiënt verwarmingssysteem	€ 4500 - € 6500	D
2	**Muur** De muur is niet geïsoleerd voor een gedeelte van 147m²	Plaats isolatie	€ 13 500 - € 15 000	B
2	**Hellend dak** Het dak is beperkt geïsoleerd.	Plaats bijkomende isolatie	€ 12 000 - € 16 000	B
3	**Hernieuwbare energie** Er is geen hernieuwbare energie aanwezig	Overweeg plaatsing hernieuwbare energie	€ 7500 - € 10 000	A
4	**Muur** De muur is geïsoleerd (voor een gedeelte van 63m²), maar er is niet voldoende isolatie anwezig om de lange termijn doelstelling te halen.	Overweeg bijkomende isolatie op het moment dat deze muur gerenoveerd wordt.		A

1 **Prioriteit 1** Niet goed, zo snel mogelijk te renoveren.

2 **Prioriteit 2** Te renoveren.

3 **Prioriteit 3** Interessant te overwegen.

4 **Prioriteit 4** Redelijk goed, puur energetische renovatie, niet aangewezen.

Volgorde van de werken & prijsinschatting

De prioriteiten zijn automatisch bepaald op basis van hoofdzakelijk energetische aspecten. De prioriteiten komen niet noodzakelijk overeen met de optimale volgorde om de werken uit te voeren. De prijs is afhankelijk van verschillende factoren die niet allemaal ingerekendz ijn. Om meer inzicht te krijgen in de beste volgorde, maakt u best een persoonlijk renovatieadvies op. Zie verder voor meer informatie.

Aandachtspunt: ventilatie

Bij een renovatie besteedt u best de nodige aandacht aan ventilatie om een goede luchtkwaliteit te bekomen.

Personaliseer uw renovatie-advies

De aanbevelingen uit het EPC en deze bijlagen zijn automatisch gegeneerd op basis van de energetische toestand van het gebouw. U kan uw advies gratis zelf personaliseren naar uw wens of behoeften op www.xyz...renovatieadvies.be .

UHASSELT
KNOWLEDGE IN ACTION

Experimental design

UHASSELT

Aim

- Verify whether the information framing plays a role in comprehension, interpretation the EPC certificate and the willingness to renovate.

- Information framing – content, wording, design
  - energy label (E)
  - recommendations (R)

UHASSELT
KNOWLEDGE IN ACTION

3 stages

- Qualitative analysis
  - Framework literature review
  - Comparative analysis 9 European EPCs
  - Focus group experts

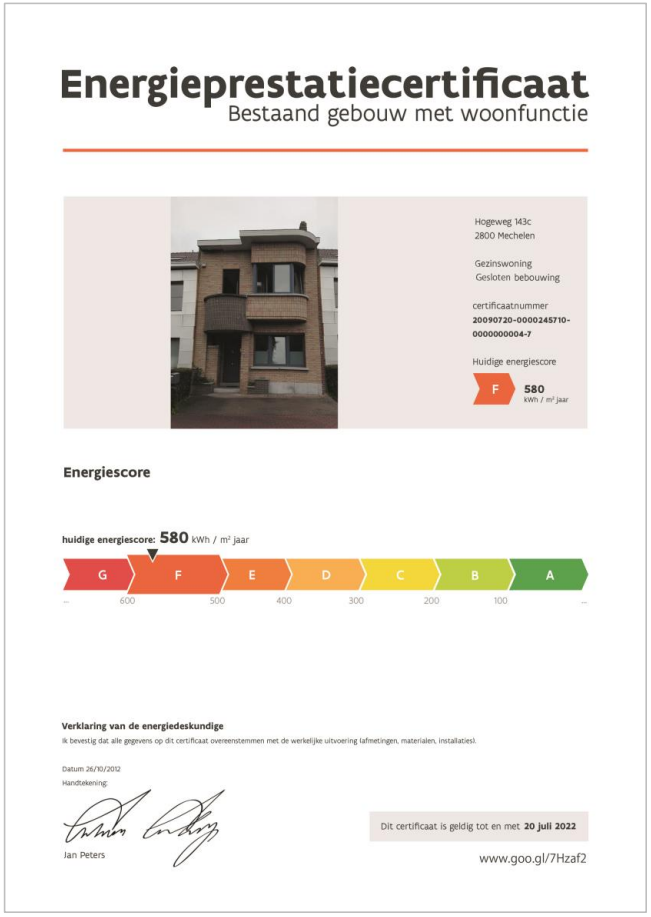
- Pilot test
  - October 2017
  - Students of the Faculty of Architecture
  - 224 usable responses
  - Rule out experimental conditions (10 E and 5 R)

- Lab experiments
  - Flemish house owners
  - February-March 2018

UHASSELT
KNOWLEDGE IN ACTION

Pilot test

- Experimental conditions
  - 10 for pag.1
  - the energy label (E)
  - 5 for pag.3
  - recommendations (R)



Energieprestatiecertificaat

Bestaand gebouw met woonfunctie

Hogeweg 143c
2800 Mechelen

Gezinswoning
Gesloten bebouwing

certificaatnummer
20090720-0000245710-0000000004-7

Huidige energiescore

F **580** kWh / m² jaar

Energiescore

huidige energiescore: 580 kWh / m² jaar

G F E D C B A

– 600 500 400 300 200 100 –

Verklaring van de energiedeskundige

Ik bevestig dat alle gegevens op dit certificaat overeenstemmen met de werkelijke uitvoering (afmetingen, materialen, installaties).

Datum 26/10/2012
Handtekening

Jan Peters

Dit certificaat is geldig tot en met **20 juli 2022**

www.goo.gl/7Hzaf2

Energieprestatiecertificaat Bestaand gebouw met woonfunctie | Hogeweg 143c 2800 Mechelen | 20090720-0000245710-0000000004-7

Overzicht aanbevelingen

		HUIDIGE SITUATIE	AANBEVELING	PRIJSSCHATTING	LABEL NA RENOVATIE
1		**Ramen** Er is momenteel nog overal enkele beglazing aanwezig	Plaats nieuw schrijnwerk met hoogrendements beglazing	€ 8000 - € 12 000	D
1		**Verwarming** Ketel is sterk verouderd en niet energiezuinig.	Plaats een efficiënt verwarmingssysteem	€ 4500 - € 6500	D
2		**Muur** De muur is niet geïsoleerd voor een gedeelte van 147m²	Plaats isolatie	€ 13 500 - € 15 000	B
2		**Hellend dak** Het dak is beperkt geïsoleerd.	Plaats bijkomende isolatie	€ 12 000 - € 16 000	B
3		**Hernieuwbare energie** Er is geen hernieuwbare energie aanwezig	Overweeg plaatsing hernieuwbare energie	€ 7500 - € 10 000	A
4		**Muur** De muur is geïsoleerd (voor een gedeelte van 63m²), maar er is niet voldoende isolatie anwezig om de lange termijn doelstelling te halen.	Overweeg bijkomende isolatie op het moment dat deze muur gerenoveerd wordt.		A

1 **Prioriteit 1** Niet goed, zo snel mogelijk te renoveren.

2 **Prioriteit 2** Te renoveren.

3 **Prioriteit 3** Interessant te overwegen.

4 **Prioriteit 4** Redelijk goed, puur energetische renovatie, niet aangewezen.

Volgorde van de werken & prijsinschatting

De prioriteiten zijn automatisch bepaald op basis van hoofdzakelijk energetische aspecten. De prioriteiten komen niet noodzakelijk overeen met de optimale volgorde om de werken uit te voeren. De prijs is afhankelijk van verschillende factoren die niet allemaal ingerekendz ijn. Om meer inzicht te krijgen in de beste volgorde, maakt u best een persoonlijk renovatieadvies op. Zie verder voor meer informatie.

Aandachtspunt: ventilatie

Bij een renovatie besteedt u best de nodige aandacht aan ventilatie om een goede luchtkwaliteit te bekomen.

Personaliseer uw renovatie-advies

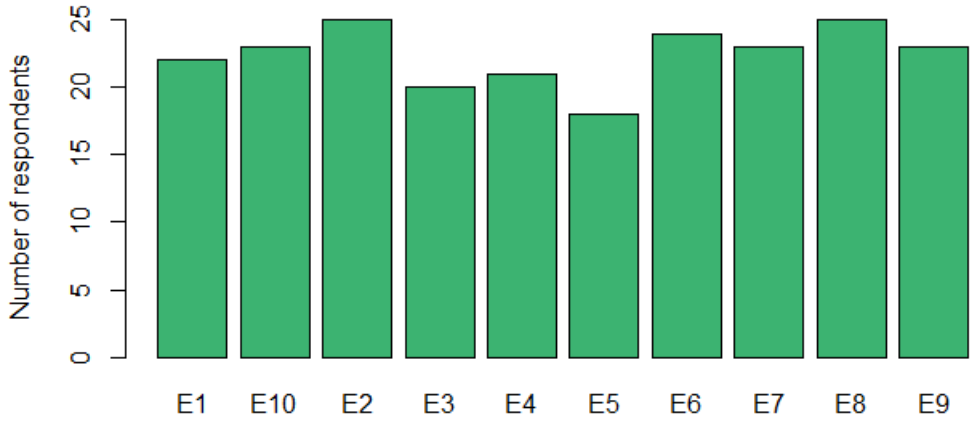
De aanbevelingen uit het EPC en deze bijlagen zijn automatisch gegeneerd op basis van de energetische toestand van het gebouw. U kan uw advies gratis zelf personaliseren naar uw wens of behoeften op www.xyz...renovatieadvies.be .

UHASSELT
KNOWLEDGE IN ACTION

Pilot test

- Dependent variables for the E conditions (energy label)
  - Perceived energy efficiency (EE) of the dwelling
    - compared to the most inefficient/efficient dwelling
  - Perceived energy consumption of an average family living in the dwelling
    - compared to the most inefficient/efficient dwelling
  - Perceived energy performance in comparison with the rest of the dwellings stock
  - Willingness to renovate

Energy label

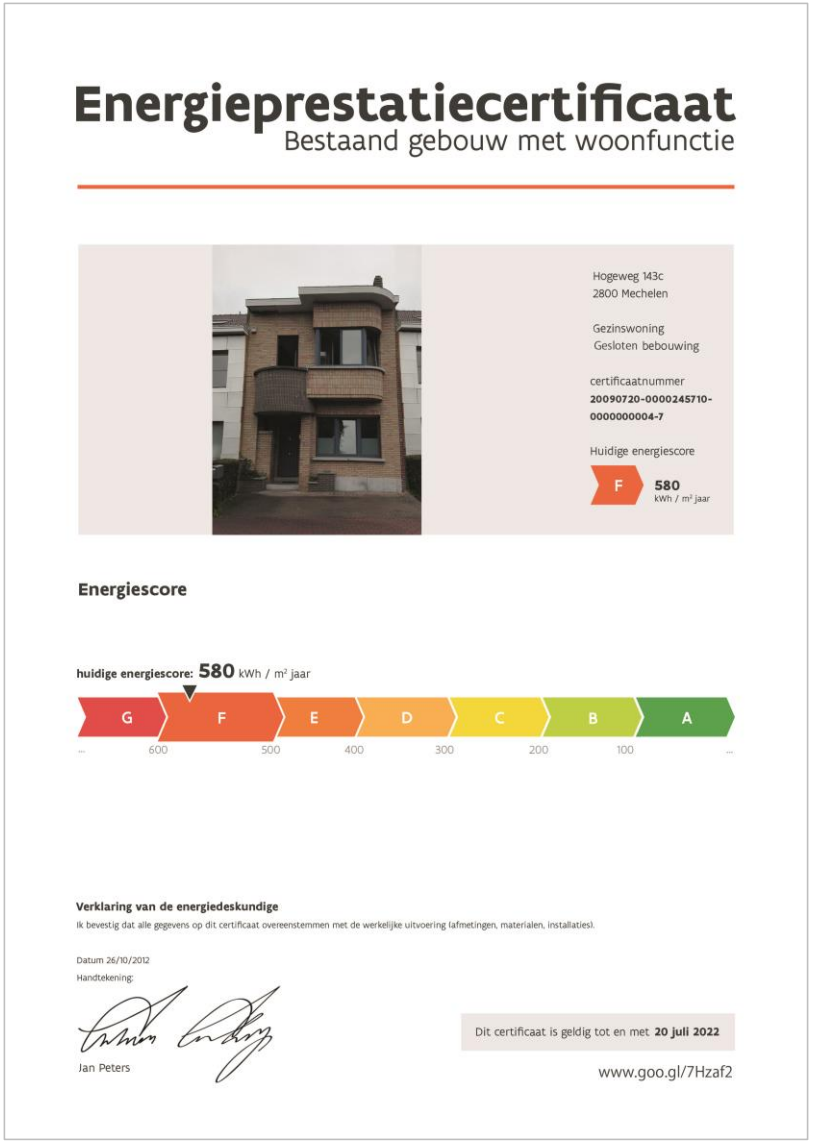


10 experimental conditions E

- E1 – VEA no reference
- E2 – VEA control condition
- E10 – VEA average same type
- E3 – text % better label
- E4 – text median building stock
- E5 – rescale F to A
- E6 – rescale F to A+, text A+
- E7 – text total energy
- E8 – graph building stock
- E9 – building stock, 3 steps

UHASSELT
KNOWLEDGE IN ACTION

Energy label



Energieprestatiecertificaat
Bestaand gebouw met woonfunctie

Hogeweg 143c
2800 Mechelen

Gezinswoning
Gesloten bebouwing

certificaatnummer
20090720-0000245710-0000000004-7

Huidige energiescore
F **580** kWh / m² jaar

Energiescore

huidige energiescore: 580 kWh / m² jaar

G F E D C B A
... 600 500 400 300 200 100 ...

Verklaring van de energiedeskundige
Ik bevestig dat alle gegevens op dit certificaat overeenstemmen met de werkelijke uitvoering (afmetingen, materialen, installaties).

Datum 26/10/2012
Handtekening:

Jan Peters

Dit certificaat is geldig tot en met **20 juli 2022**

www.goo.gl/7Hzaf2

10 experimental conditions E

- E1 – VEA no references
- E2 – VEA control condition
- E10 – VEA average same type
- E3 – text % better label
- E4 – text median building stock
- E5 – rescale F to A
- E6 – rescale F to A+, text A+
- E7 – text total energy
- E8 – graph building stock
- E9 – building stock, 3 steps

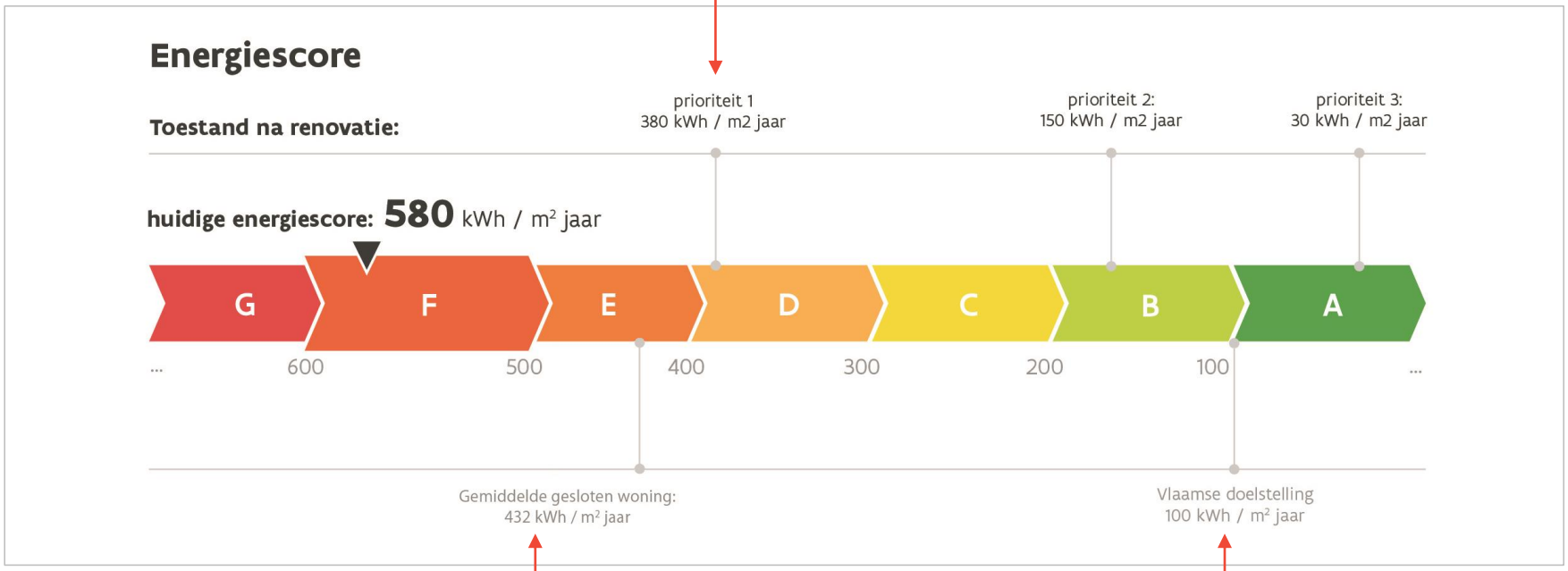
UHASSELT
KNOWLEDGE IN ACTION

Energy label

10 experimental conditions E

- E2 – VEA control condition
  - Anchoring
  - Social norm
  - Information overload

- 3 steps renovation



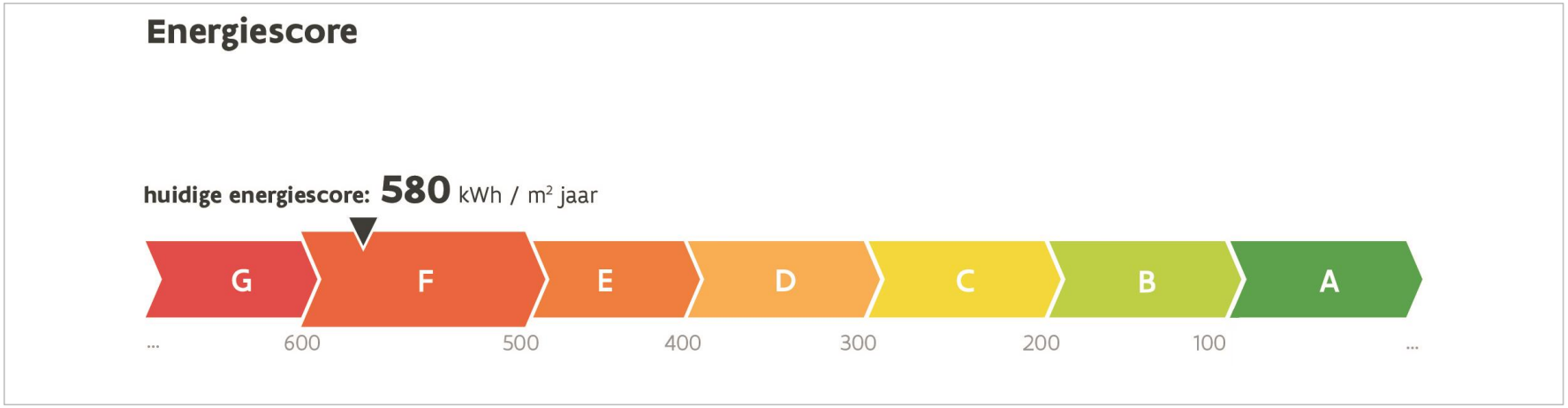
- Average score dwellings of the same typology
- VEA goal 2050

UHASSELT
KNOWLEDGE IN ACTION

Energy label

10 experimental conditions E

- E1 – VEA no references



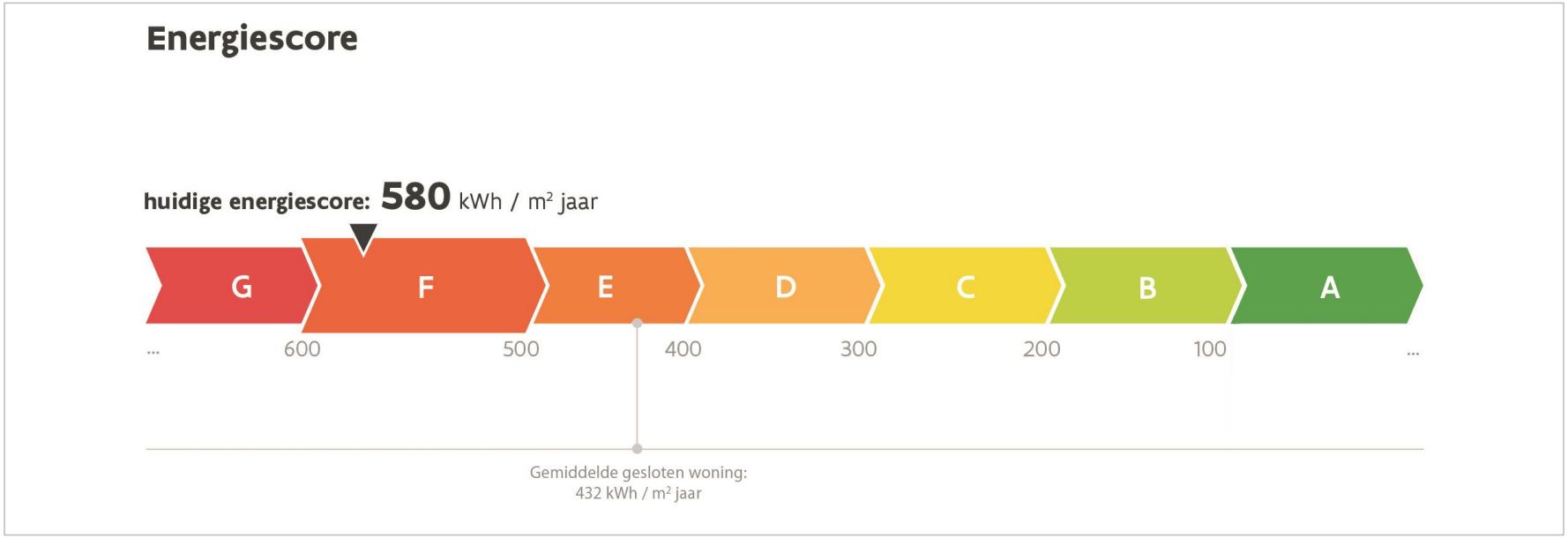
UHASSELT
KNOWLEDGE IN ACTION

Energy label

10 experimental conditions E

E10 – VEA only average

- Anchoring (not ambitious)
- Social norm



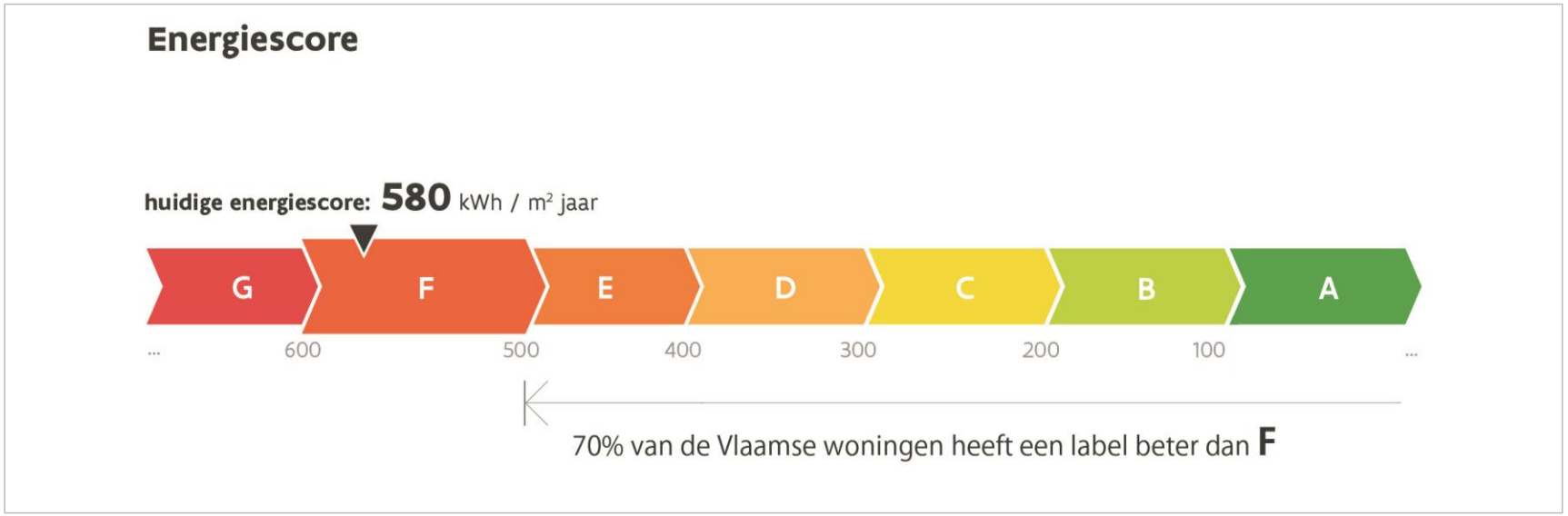
- Average score dwellings of the same typology

UHASSELT
KNOWLEDGE IN ACTION

Energy label

10 experimental conditions E

- E3 – text % better label
  - Social norm



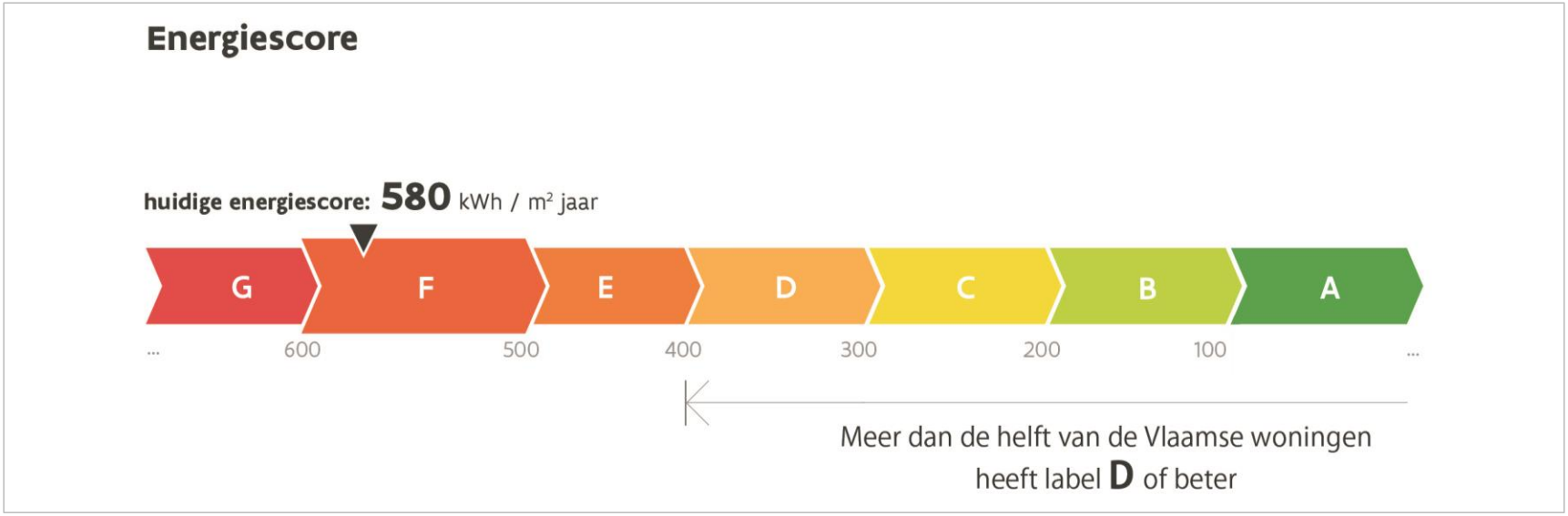
- 70% of the Flemish dwellings have a better label than F

UHASSELT
KNOWLEDGE IN ACTION

Energy label

10 experimental conditions E

- E4 – text median building stock
  - Anchoring
  - Social norm



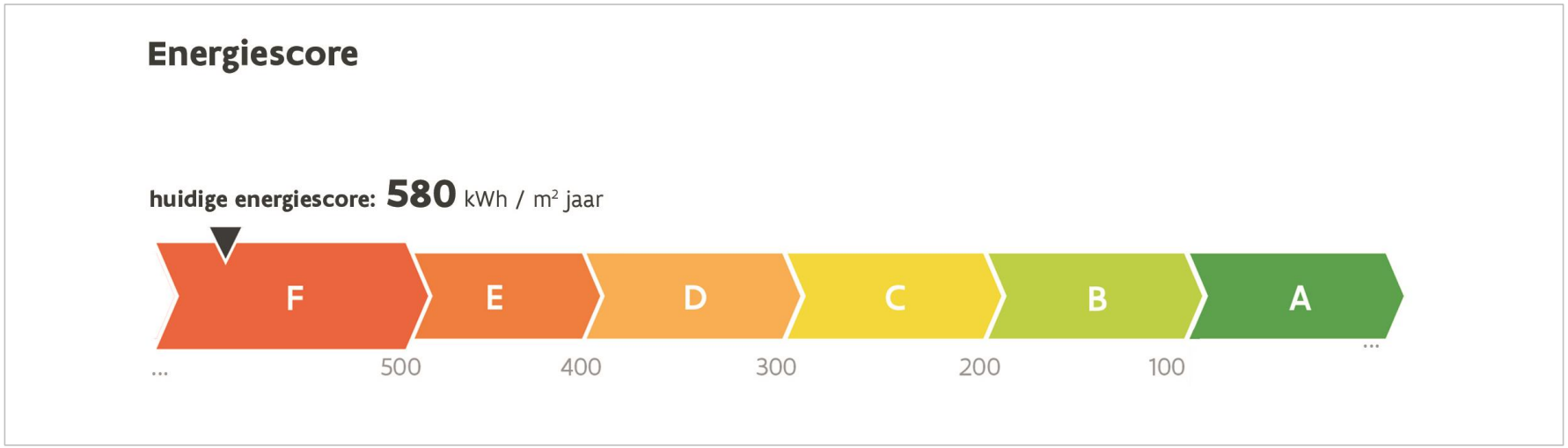
- More than half of the Flemish dwellings have label D or better

UHASSELT
KNOWLEDGE IN ACTION

Energy label

10 experimental conditions E

- E5 – rescale F to A
  - Range effects



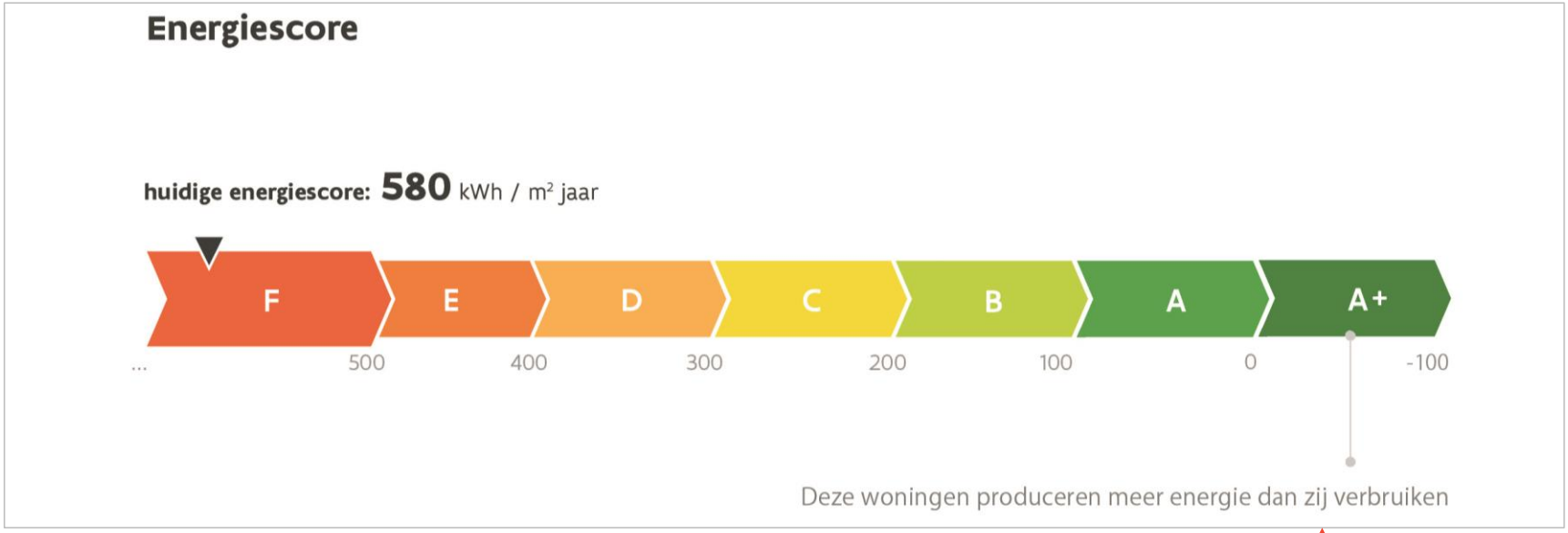
- Rescaling F to A instead of G to A

UHASSELT
KNOWLEDGE IN ACTION

Energy label

10 experimental conditions E

- E6 – rescale F to A+, text A+
  - Range effects
  - Anchoring



- Rescaling F to A+ instead of G to A
- These dwellings produce more energy than consume

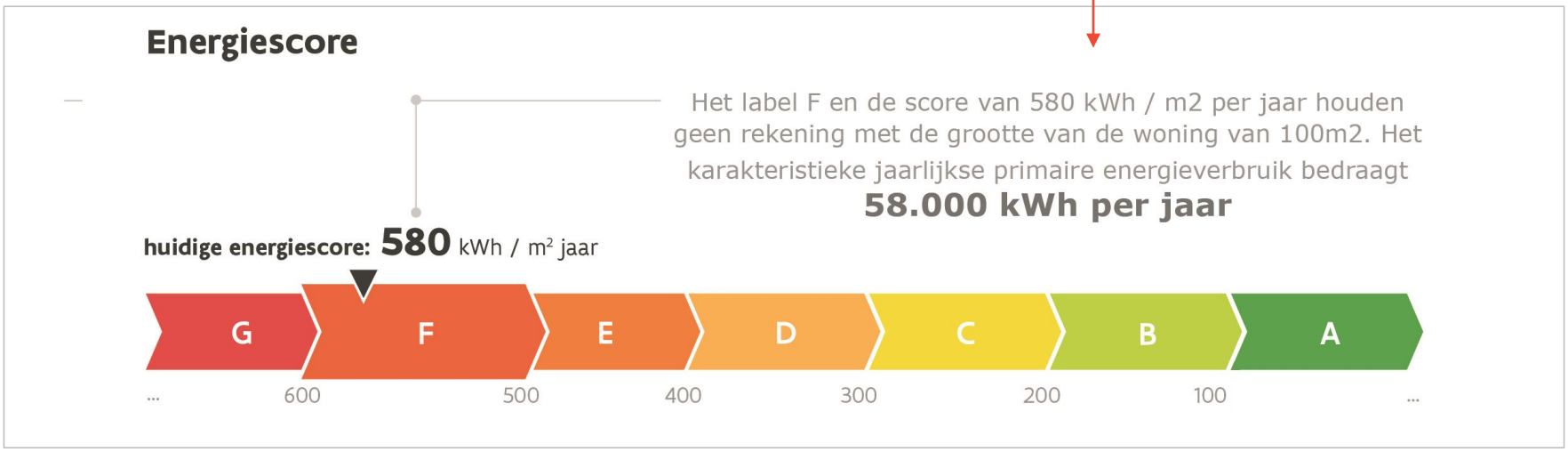
UHASSELT
KNOWLEDGE IN ACTION

Energy label

10 experimental conditions E

- E7 – text total energy

- Label F of 580 kWh/m^2 per year does not take into account the size of the dwelling of 100m2. The total primary energy amounts in 58.000 kWh per year.

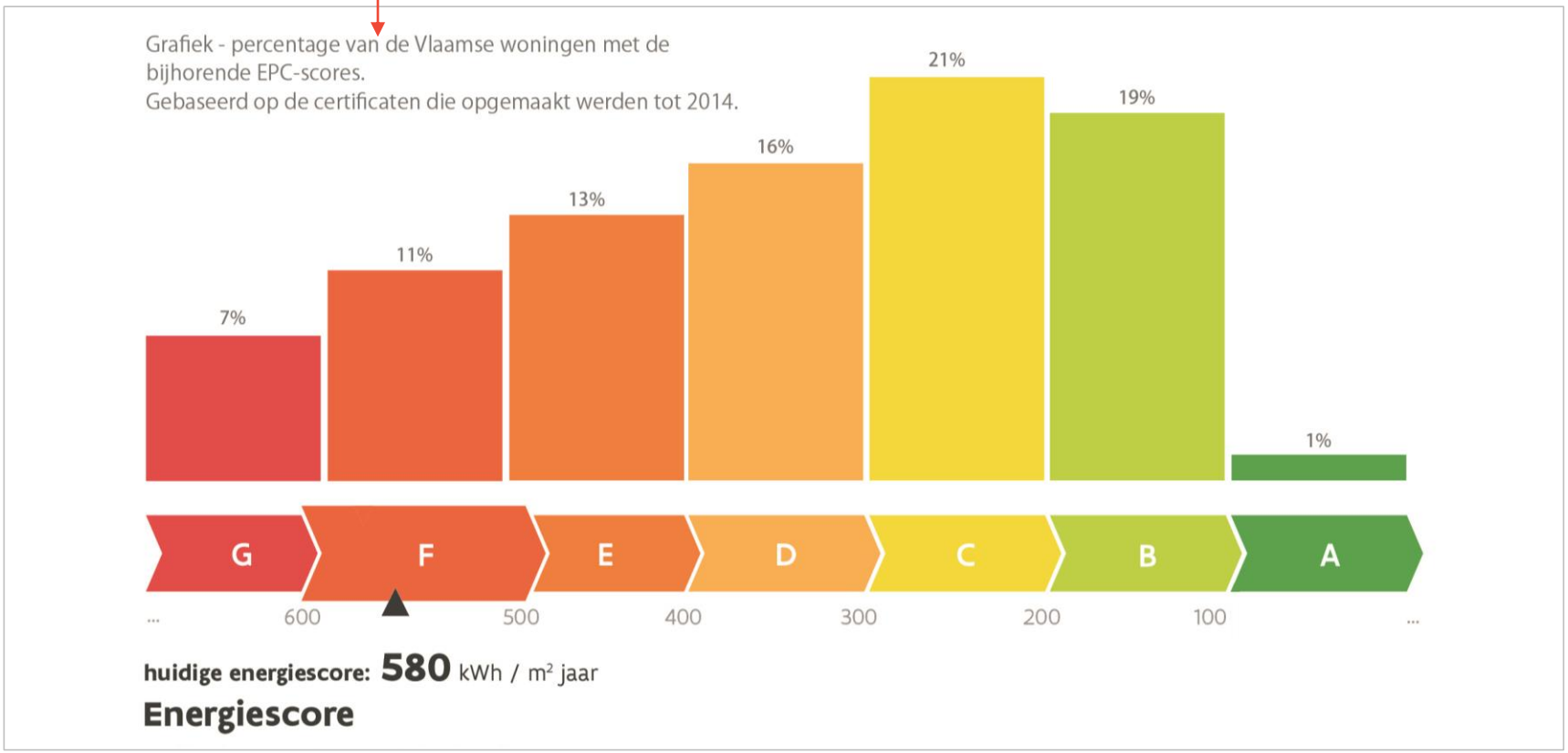


Energy label

- Graphic – percentage of the Flemish dwellings with the respective EPC scores

10 experimental conditions E

- E8 – graph building stock
  - Social norm

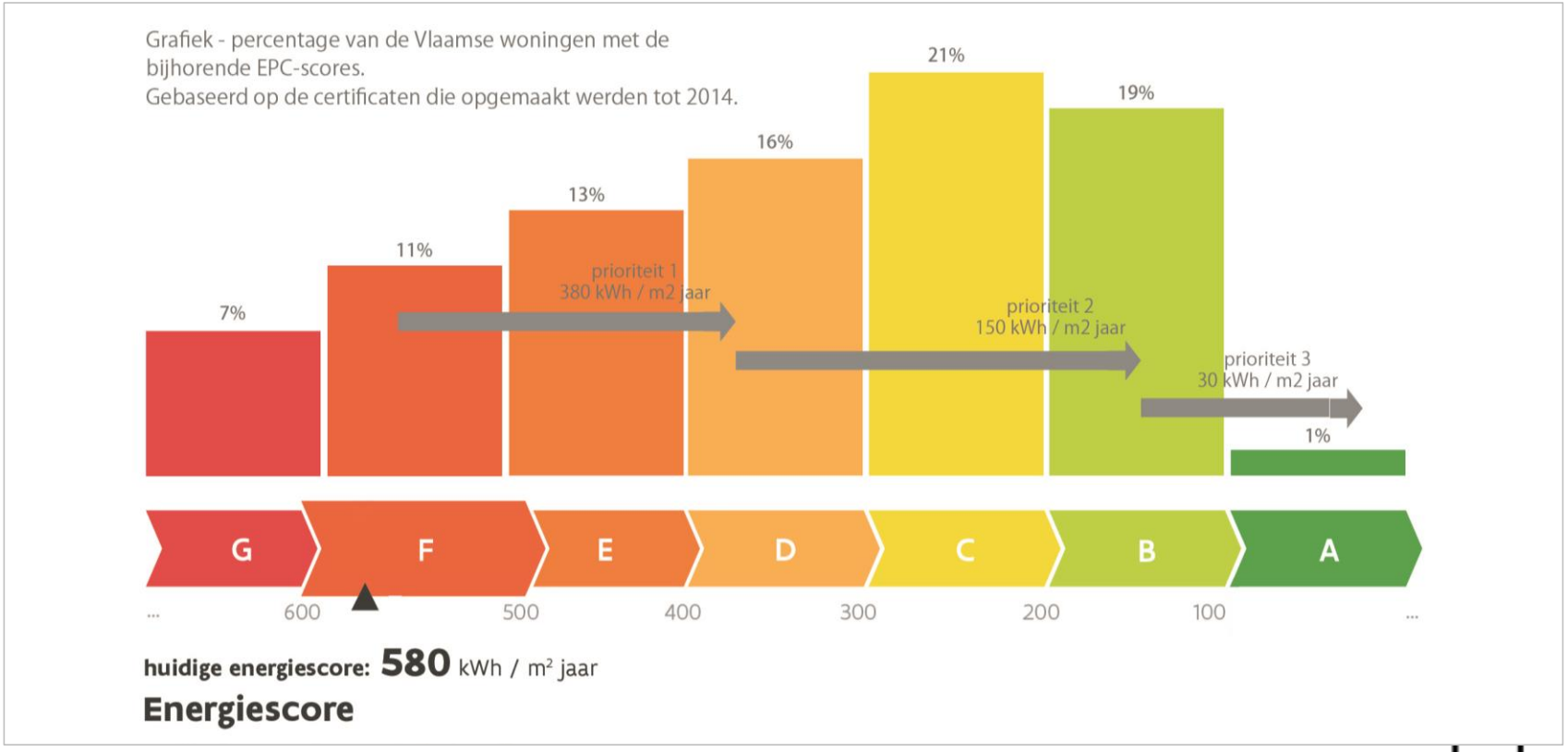


UHASSELT
KNOWLEDGE IN ACTION

Energy label

10 experimental conditions E

- E9 – building stock, 3 steps
  - Social norm
  - Anchoring
  - Information overload



UHASSELT
KNOWLEDGE IN ACTION

Pilot test

- Experimental conditions
  - 10 for energy performance indicator, energy label (E)
  - 5 for recommendations (R)
- Between subjects design
  - 1 respondent presented with 1 experimental condition
  - 1 respondent presented with 2 dwellings
    - Dwelling labelled F - red EPC score 580
    - Dwelling labelled C - yellow EPC score 230
- Randomisation
  - 100 different surveys
  - Randomised order of the dwellings F,C
  - Randomised combination of conditions E,R

UHASSELT
KNOWLEDGE IN ACTION

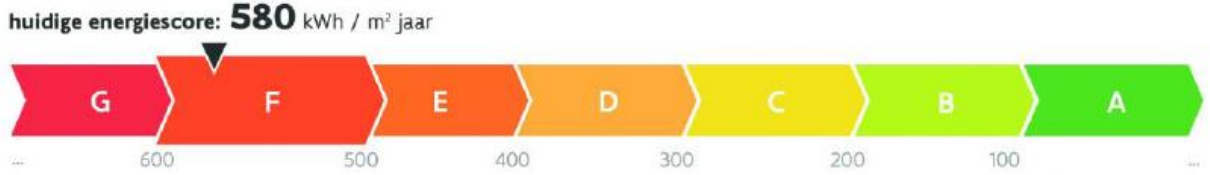
Main results

UHASSELT

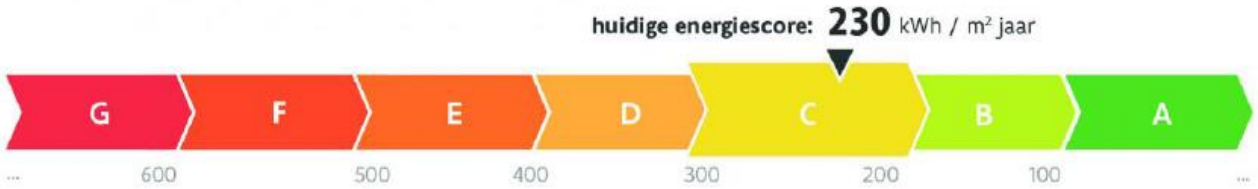
Energy label relative to size

- Which of the following two dwellings would have higher energy bills if you assume that they are inhabited by the same family?

○ **Dwelling 1**
Size 100m²

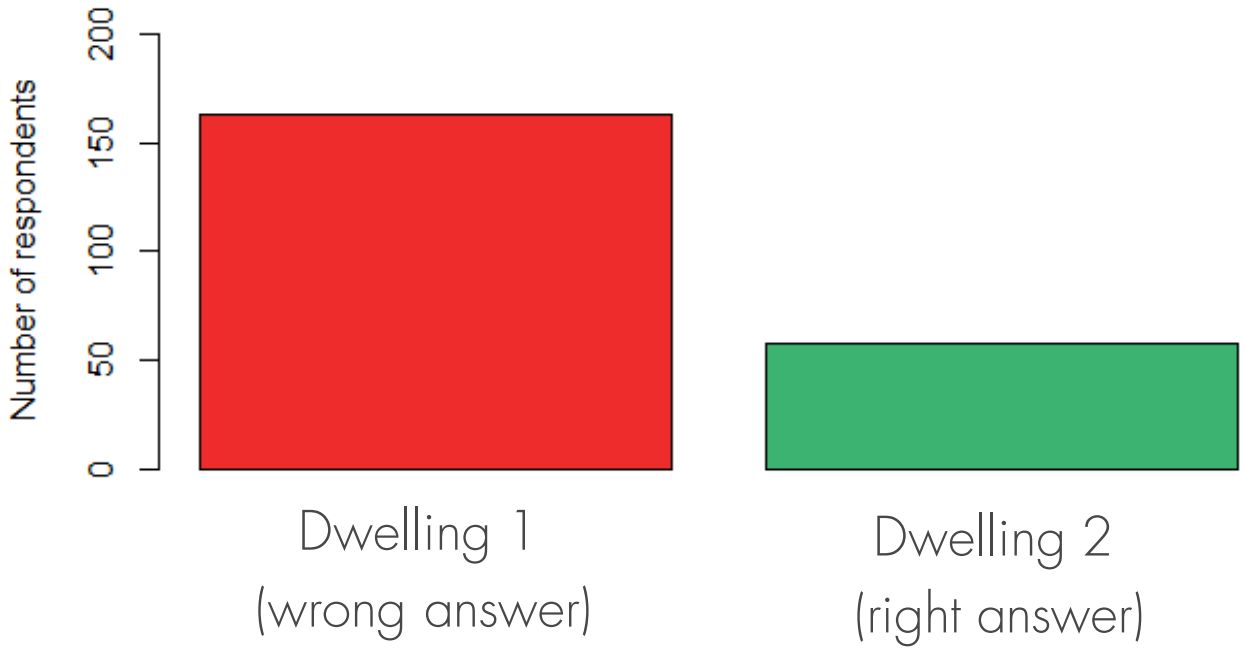


○ **Dwelling 2**
Size 300m²



UHASSELT
KNOWLEDGE IN ACTION

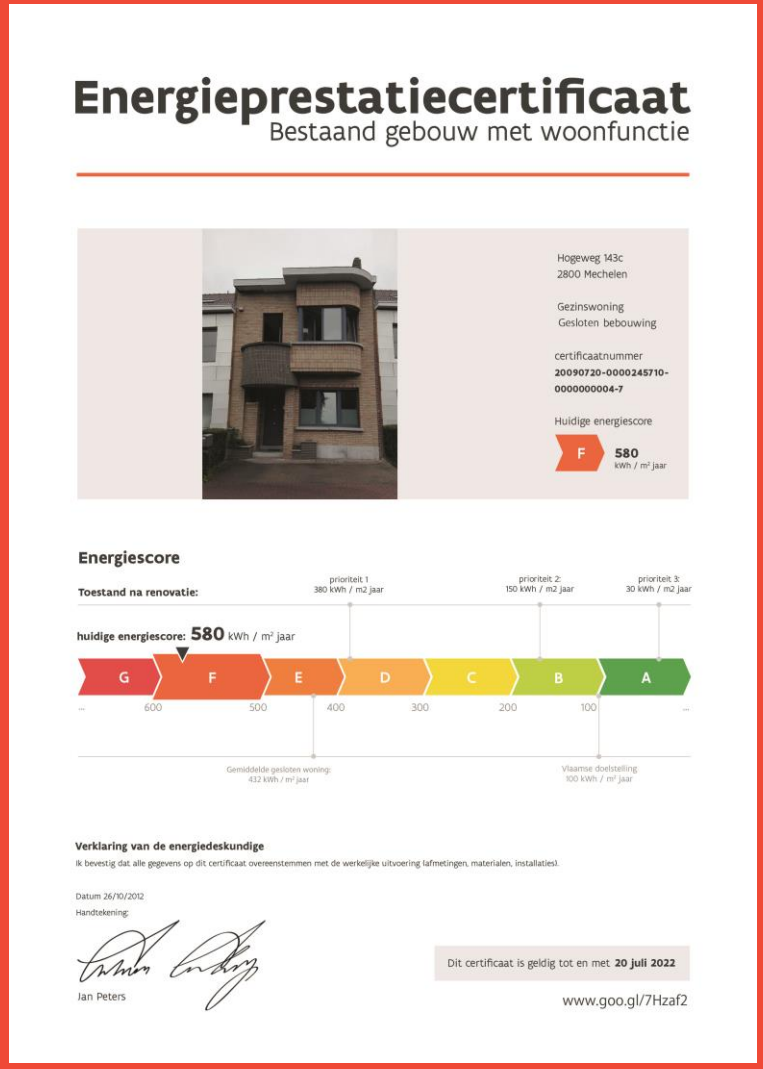
Energy label – comprehension and interpretation



- 72% of the respondents do not realize that EPC score does not illustrate the total energy, but it is relative to the size of the dwelling

Energy label

Impact of various information framings



Energieprestatiecertificaat

Bestaand gebouw met woonfunctie

Hogeweg 143c
2800 Mechelen

Gezinswoning
Gesloten bebouwing

certificaatnummer
20090720-0000245710-0000000004-7

Huidige energiescore

F **580** kWh / m² jaar

Energiescore

Toestand na renovatie:

prioriteit 1: 380 kWh / m2 jaar
prioriteit 2: 150 kWh / m2 jaar
prioriteit 3: 30 kWh / m2 jaar

huidige energiescore: 580 kWh / m² jaar

G F E D C B A

... 600 500 400 300 200 100 ...

Gemiddelde gesloten woning: 432 kWh / m² jaar

Vlaamse doelstelling: 100 kWh / m² jaar

Verklaring van de energiedeskundige

Ik bevestig dat alle gegevens op dit certificaat overeenstemmen met de werkelijke uitvoering (afmetingen, materialen, installaties).

Datum 26/10/2012

Handtekening:

Jan Peters

Dit certificaat is geldig tot en met **20 juli 2022**

www.goo.gl/7Hzaf2

UHASSELT

Perceived energy consumption

Experimental conditions - E energy label

UHASSELT

Energy label - Perceived energy consumption

2. In your opinion, how much energy would an average Flemish family consume living in this house?

- O very few
- O below average
- O average
- O above average
- O a lot

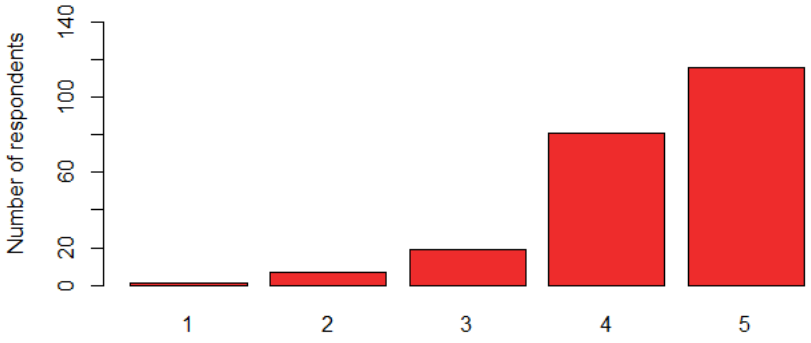
Assigned points 1 to 5

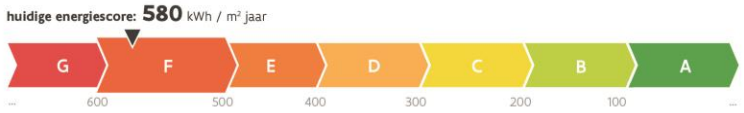
- 1 few energy
- 5 a lot of energy

UHASSELT
KNOWLEDGE IN ACTION

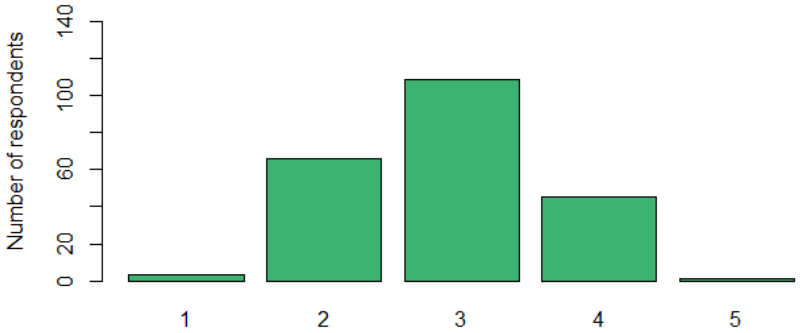
Energy label - Perceived energy consumption

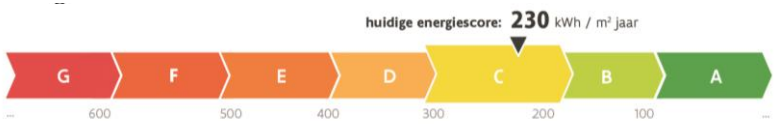
Dwelling F





Dwelling C



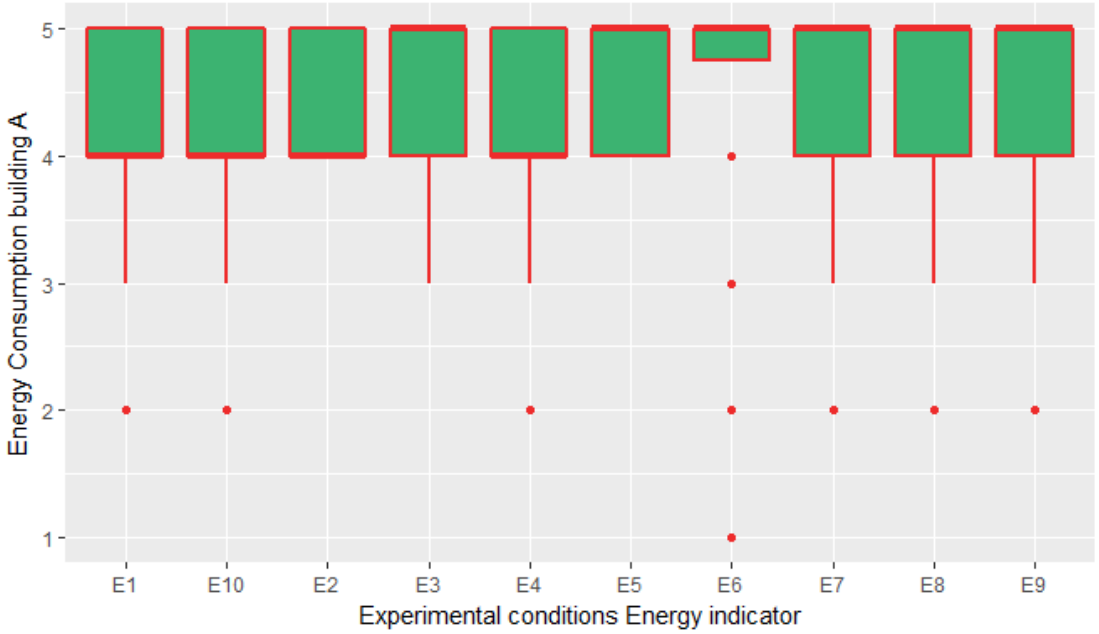


- 1 few energy
- 5 a lot of energy

UHASSELT
KNOWLEDGE IN ACTION

Energy label - Perceived energy consumption dwelling F

Perceived energy consumption dwelling F per 10 experimental conditions of the energy indicator



- E1 – VEA clean
- E2 – VEA control condition
- E10 – VEA average same type
- E3 – text % better label
- E4 – text median building stock
- E5 – rescale F to A
- E6 – rescale F to A+, text A+
- E7 – text total energy
- E8 – graph building stock
- E9 – building stock, 3 steps

Perceived energy consumption

- 1 few energy
- 5 a lot of energy

UHASSELT
KNOWLEDGE IN ACTION

Energy label - Perceived energy consumption dwelling F

- ANOVA

	E1	E10	E2	E3	E4	E5	E6	E7	E8	E9
Mean 4.357	4.318	4.043	4.48	4.5	4.19	4.611	4.5	4.391	4.32	4.261

ANOVA Kruskal-Wallis

chi-squared	df	p-value
10.823	9	0.288

- Not significant

- Independent of the information framing, all the respondents agreed that dwelling labelled F consumes a lot of energy

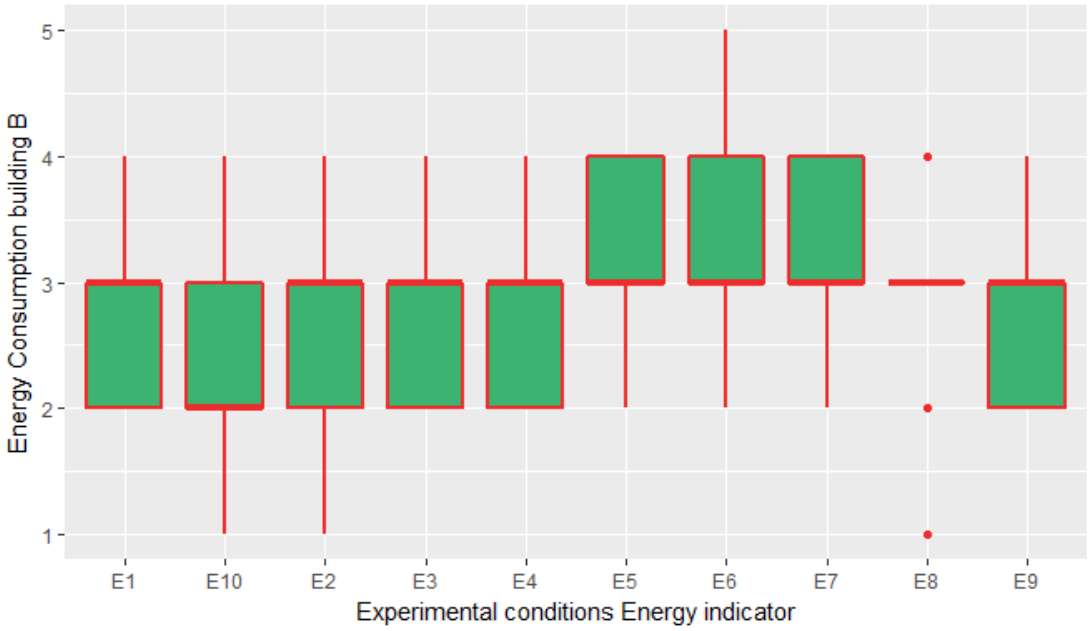
(mean 4.357 for 4 –more than average, 5- a lot)

- E1 – VEA clean
- E2 – VEA control condition
- E10 – VEA average same type
- E3 – text % better label
- E4 – text median building stock
- E5 – rescale F to A
- E6 – rescale F to A+, text A+
- E7 – text total energy
- E8 – graph building stock
- E9 – building stock, 3 steps

UHASSELT
KNOWLEDGE IN ACTION

Energy label - Perceived energy consumption dwelling C

Perceived energy consumption dwelling C per 10 experimental conditions of the energy indicator



- E1 – VEA clean
- E2 – VEA control condition
- E10 – VEA average same type
- E3 – text % better label
- E4 – text median building stock
- E5 – rescale F to A
- E6 – rescale F to A+, text A+
- E7 – text total energy
- E8 – graph building stock
- E9 – building stock, 3 steps

Perceived energy consumption - 1 to 5:

- 1 few energy
- 5 a lot of energy

UHASSELT
KNOWLEDGE IN ACTION

Energy indicator - Perceived energy consumption dwelling C

- ANOVA

	E1	E10	E2	E3	E4	E5	E6	E7	E8	E9
Mean 2.888	2.682	2.435	2.84	2.75	2.762	3.222	3.208	3.261	2.96	2.783

ANOVA Kruskal-Wallis

chi-squared	df	p-value
26.244	9	0.001863

- Significant

- E1 – VEA clean
- E2 – VEA control condition
- E10 – VEA average same type
- E3 – text % better label
- E4 – text median building stock
- E5 – rescale F to A
- E6 – rescale F to A+, text A+
- E7 – text total energy
- E8 – graph building stock
- E9 – building stock, 3 steps

UHASSELT
KNOWLEDGE IN ACTION

Energy label - Perceived energy consumption dwelling C

- ANOVA TukeyHSD test

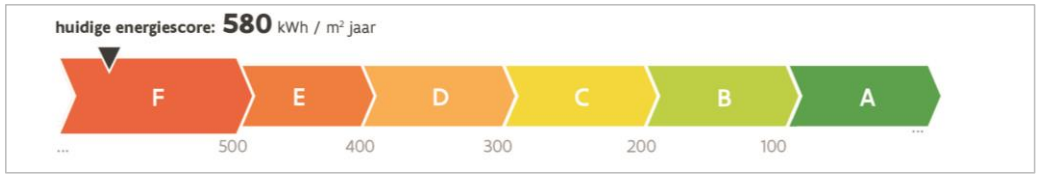
	diff	p adj
E10-E1	-0.24703557	0.9778262
E2-E1	0.15818182	0.9990626
E3-E1	0.06818182	0.9999995
E4-E1	0.08008658	0.9999979
E5-E1	0.54040404	0.3464117
E6-E1	0.52651515	0.2792149
E7-E1	0.57905138	0.1756759
E8-E1	0.27818182	0.9458956
E9-E1	0.10079051	0.9999814
E2-E10	0.40521739	0.6288359
E3-E10	0.31521739	0.9132017
E4-E10	0.32712215	0.8854999
E5-E10	0.78743961	0.0200761
E6-E10	0.77355072	0.0100042
E7-E10	0.82608696	0.0047283
E8-E10	0.52521739	0.2542224
E9-E10	0.34782609	0.8231096
E3-E2	-0.09000000	0.9999933
E4-E2	-0.07809524	0.9999978
E5-E2	0.38222222	0.7790466
E6-E2	0.36833333	0.7345763
E7-E2	0.42086957	0.5758529
E8-E2	0.12000000	0.9998719

	diff	p adj
E9-E2	-0.05739130	0.9999998
E4-E3	0.01190476	1.0000000
E5-E3	0.47222222	0.5790004
E6-E3	0.45833333	0.5196325
E7-E3	0.51086957	0.3719183
E8-E3	0.21000000	0.9932324
E9-E3	0.03260870	1.0000000
E5-E4	0.46031746	0.5990173
E6-E4	0.44642857	0.5390667
E7-E4	0.49896480	0.3877096
E8-E4	0.19809524	0.9951478
E9-E4	0.02070393	1.0000000
E6-E5	-0.01388889	1.0000000
E7-E5	0.03864734	1.0000000
E8-E5	-0.26222222	0.9740112
E9-E5	-0.43961353	0.6342076
E7-E6	0.05253623	0.9999999
E8-E6	-0.24833333	0.9695397
E9-E6	-0.42572464	0.5735785
E8-E7	-0.30086957	0.9081575
E9-E7	-0.47826087	0.4162413
E9-E8	-0.17739130	0.9974763

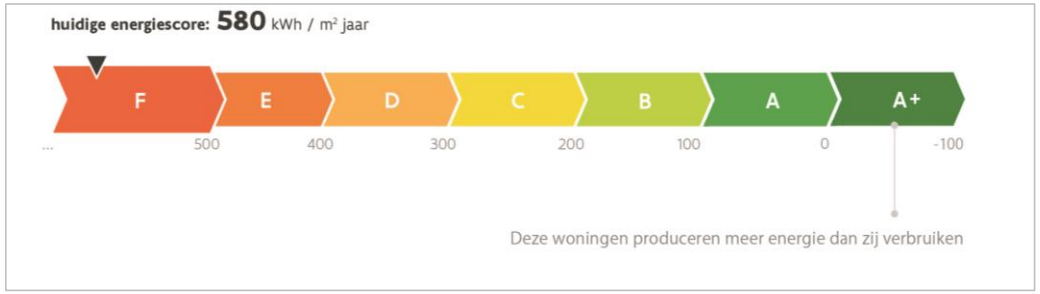
UHASSELT
KNOWLEDGE IN ACTION

Energy label – Energy consumption dwelling C

- Dwelling rated C is estimated that it consumes more energy, less optimistically with E5, E6 and E7 compared to E10



E5 – rescale F to A



E6 – rescale F to A+, anchor A+

E7 – text total energy

E10 – VEA only average
Similar to control condition

UHASSELT
KNOWLEDGE IN ACTION

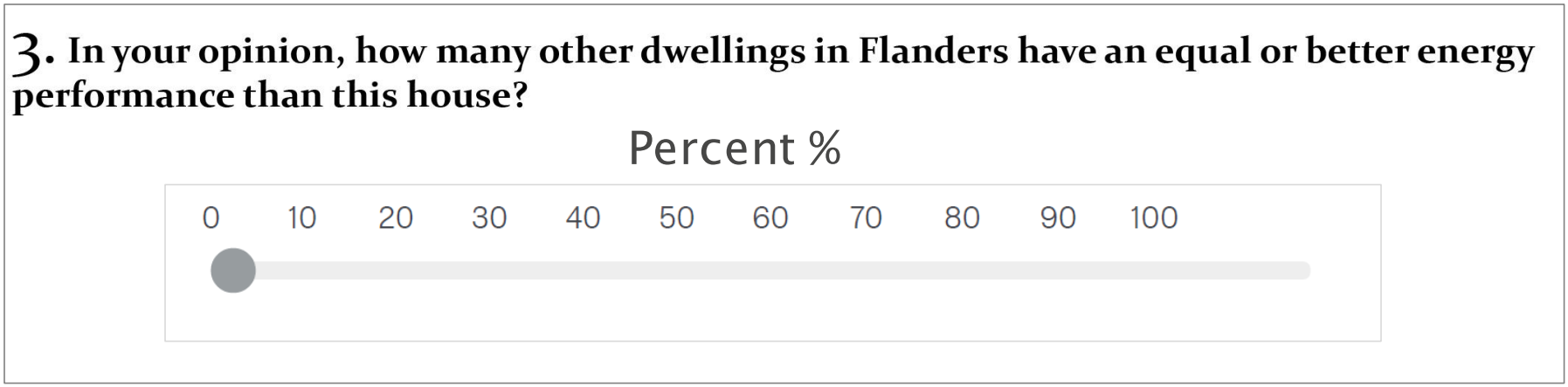
Comparison with the rest of the building stock

Experimental conditions - E energy label

Percentage of the dwellings performing better

UHASSELT

Energy label – Percentage performing better than dwelling F

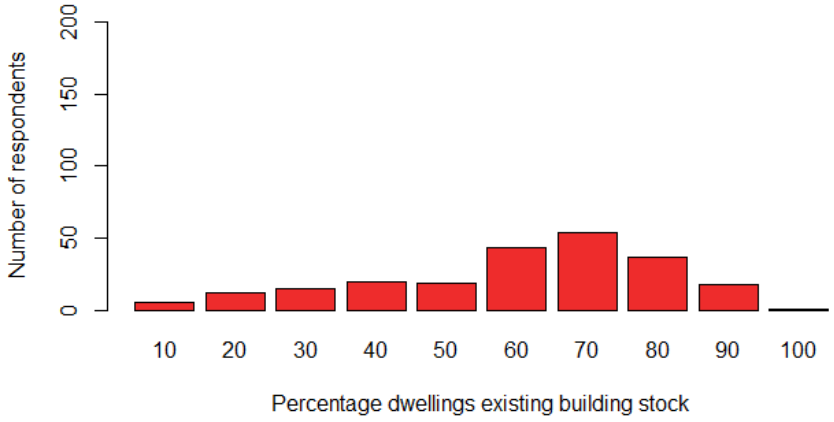


The estimation is compared with the actual number of the Flemish building stock

UHASSELT
KNOWLEDGE IN ACTION

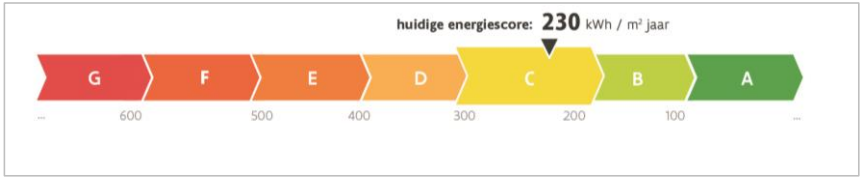
Energy label – Percentage dwellings performing better

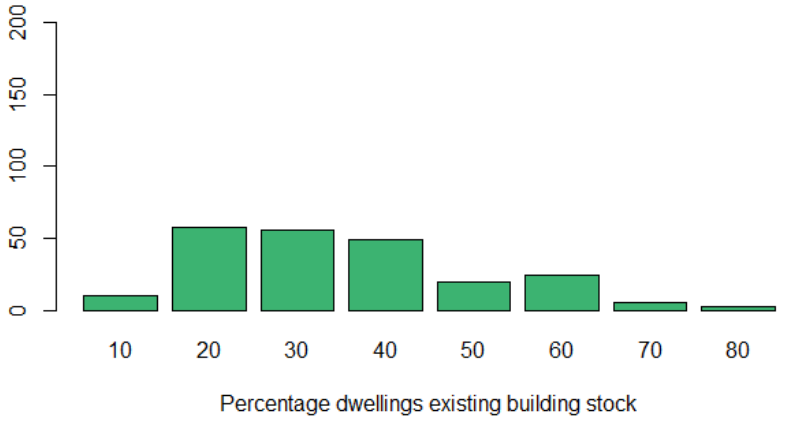
Dwelling F



Actual number building stock 70%

Dwelling C





Actual number building stock 20%

UHASSELT
KNOWLEDGE IN ACTION

Energy label – Percentage performing better than dwelling F

t.test H0 mean diff (X-70) is equal to 0

t	df	p-value
-7.032	223	2.462e-11

- Significant

Mean estimation - 60.4% Building stock - 70%

Respondents underestimated the percentage of the dwellings performing better.

- optimistic assessment of the dwelling F
- pessimistic assessment of the building stock

UHASSELT
KNOWLEDGE IN ACTION

Energy label – Percentage performing better than dwelling F

Estimation percentage dwellings performing better than dwelling F compared with the actual figure of 70% of the building stock per 10 experimental conditions of the energy label

	Mean (X-70)	t	df	p-value
E1	-22.73	-4.7818	21	0.0001005
E2	-9.6	-2.6134	24	0.01523
E3	-6	-1.9827	19	0.06205
E4	-10.95	-2.5446	20	0.0193
E5	-12.22	-2.2907	17	0.03503
E6	-4.58	-1.1615	23	0.2574
E7	-7.39	-2.1042	22	0.04702
E8	-2.4	-0.63187	24	0.5334
E9	-5.65	-1.1434	22	0.2652
E10	-16.09	-3.4273	22	0.002409

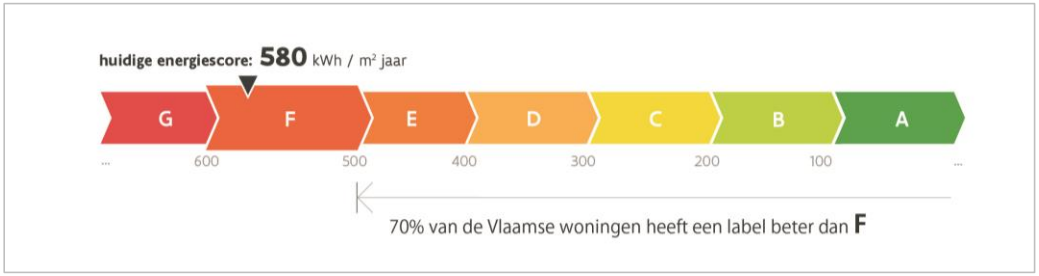
t.test

H0 Mean of the difference (X-70) is equal to 0

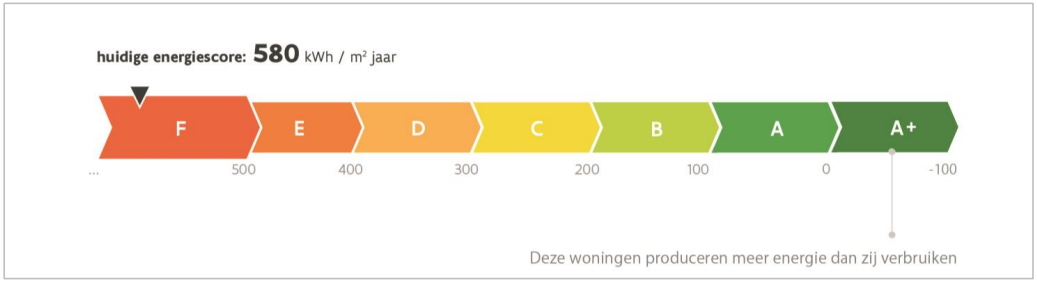
UHASSELT
KNOWLEDGE IN ACTION

Energy label – Percentage performing better than dwelling F

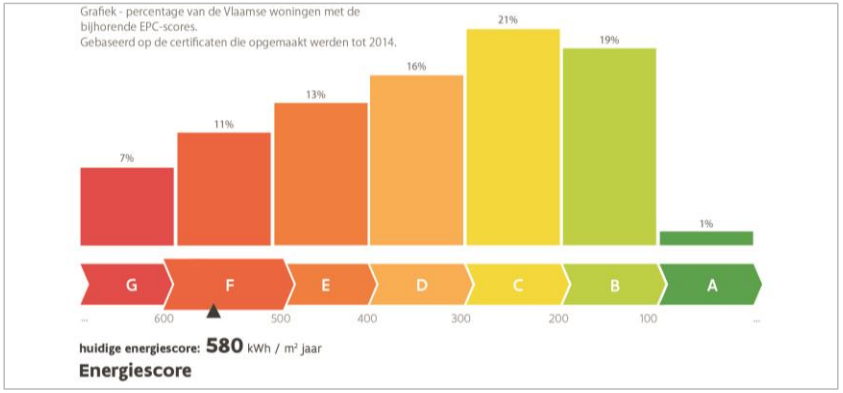
With E3, E6, E8, E9 respondents could estimate correctly the percentage of the dwellings performing better than dwelling F. There is no significant difference between the mean estimation of these subgroups and the actual value of the building stock of 70%



E3 – text, % better label



E6 – rescale F to A+, text A+



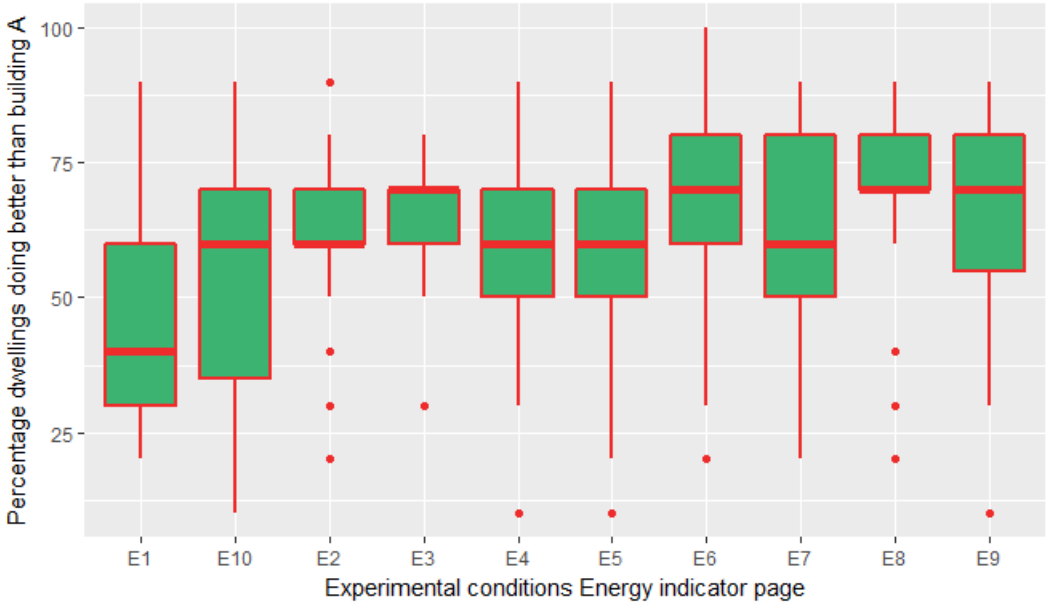
E8 – graph building stock

E9 – graph building stock, 3 steps renovation

UHASSELT
KNOWLEDGE IN ACTION

Energy label – Percentage better off- dwelling F

Percentage of the dwellings performing better than dwelling F per 10 experimental conditions of the energy label



- E1 – VEA clean
- E2 – VEA control condition
- E10 – VEA average same type
- E3 – text % better label
- E4 – text median building stock
- E5 – rescale F to A
- E6 – rescale F to A+, text A+
- E7 – text total energy
- E8 – graph building stock
- E9 – building stock, 3 steps

UHASSELT
KNOWLEDGE IN ACTION

Energy label – Percentage performing better than dwelling F

Actually 70%

	E1	E10	E2	E3	E4	E5	E6	E7	E8	E9
Mean 60.40	47.27	53.91	60.4	64	59.05	57.78	65.42	62.61	67.6	64.35

ANOVA Kruskal-Wallis

chi-squared	df	p-value
18.188	9	0.03306

- Significant

- E1 – VEA clean
- E2 – VEA control condition
- E10 – VEA average same type
- E3 – text % better label
- E4 – text median building stock
- E5 – rescale F to A
- E6 – rescale F to A+, text A+
- E7 – text total energy
- E8 – graph building stock
- E9 – building stock, 3 steps

UHASSELT
KNOWLEDGE IN ACTION

Energy label – Percentage performing better than dwelling F

- ANOVA TukeyHSD test

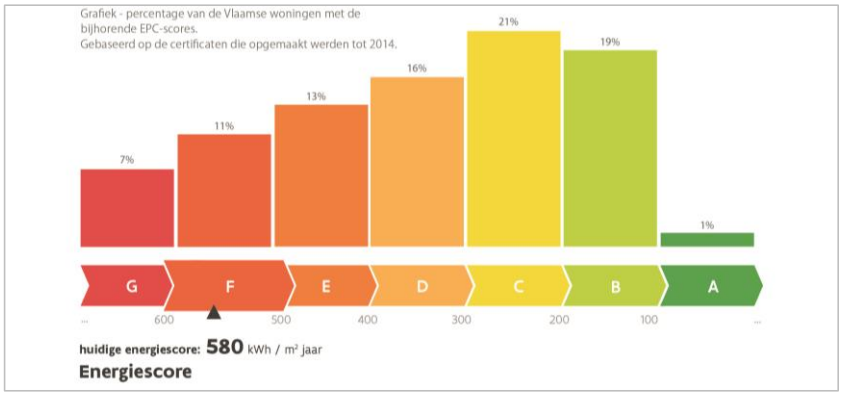
	diff	p adj
E10-E1	6.6403162	0.9828649
E2-E1	13.1272727	0.4285993
E3-E1	16.7272727	0.1769891
E4-E1	11.7748918	0.6480881
E5-E1	10.5050505	0.8198421
E6-E1	18.1439394	0.0706157
E7-E1	15.3359684	0.2372863
E8-E1	20.3272727	0.0211361
E9-E1	17.0750988	0.1224216
E2-E10	6.4869565	0.9818621
E3-E10	10.0869565	0.8214677
E4-E10	5.1345756	0.9976182
E5-E10	3.8647343	0.9998268
E6-E10	11.5036232	0.6194434
E7-E10	8.6956522	0.9005423
E8-E10	13.6869565	0.3493672
E9-E10	10.4347826	0.7531030
E3-E2	3.6000000	0.9998571
E4-E2	-1.3523810	1.0000000
E5-E2	-2.6222222	0.9999926
E6-E2	5.0166667	0.9969688
E7-E2	2.2086957	0.9999970

	diff	p adj
E8-E2	7.2000000	0.9585002
E9-E2	3.9478261	0.9995828
E4-E3	-4.9523810	0.9986276
E5-E3	-6.2222222	0.9941668
E6-E3	1.4166667	1.0000000
E7-E3	-1.3913043	1.0000000
E8-E3	3.6000000	0.9998571
E9-E3	0.3478261	1.0000000
E5-E4	-1.2698413	1.0000000
E6-E4	6.3690476	0.9873606
E7-E4	3.5610766	0.9998760
E8-E4	8.5523810	0.9112944
E9-E4	5.3002070	0.9969610
E6-E5	7.6388889	0.9675282
E7-E5	4.8309179	0.9989347
E8-E5	9.8222222	0.8519498
E9-E5	6.5700483	0.9890870
E7-E6	-2.8079710	0.9999780
E8-E6	2.1833333	0.9999970
E9-E6	-1.0688406	1.0000000
E8-E7	4.9913043	0.9973191
E9-E7	1.7391304	0.9999997
E9-E8	-3.2521739	0.9999164

UHASSELT
KNOWLEDGE IN ACTION

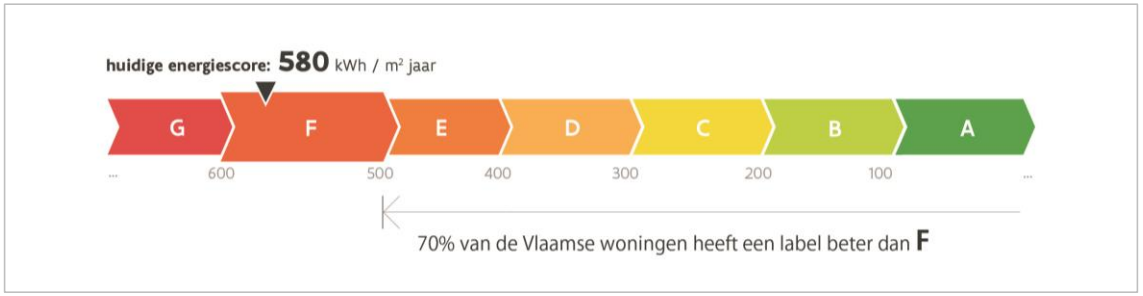
Energy label – Percentage performing better than dwelling F

- With E8 respondents estimate that a higher percentage of dwellings perform better tan dwelling rated F compared to condition E1 (similar to control condition)



E8 – graph building stock

- E3 explicitly states this number, yet it does not show significant differences with the control conditions



E3 – text, % better label

UHASSELT
KNOWLEDGE IN ACTION

Energy label – Percentage performing better than dwelling C

t.test H0 mean diff (X-20) is equal to 0

t	df	p-value
14.803	223	2.2e-16

- Significant

Mean estimation - 35% Building stock - 20%

Respondents overestimated the percentage of the dwellings performing better.

- pessimistic assessment the dwelling labelled C
- optimistic assessment of the dwelling stock

UHASSELT
KNOWLEDGE IN ACTION

Energy label – Percentage performing better than dwelling C

compared with the actual figure of 20% of the building stock per 10 experimental conditions of the energy label

t.test H0 mean diff (X-20) is equal to 0

	Mean (X-20)	t	df	p-value
E1	17.73	5.889	21	7.604e-06
E2	11.6	4.1288	24	0.0003803
E3	8	3.387	19	0.003094
E4	18.09	4.5225	20	0.0002076
E5	18.89	4.8836	17	0.0001399
E6	21.25	6.5206	23	1.183e-06
E7	15.65	5.5913	22	1.275e-05
E8	13.6	3.9325	24	0.0006247
E9	14.78	4.232	22	0.0003424
E10	11.31	4.7541	22	9.571e-05

For all the experimental conditions respondents overestimate the percentage of the dwellings performing better than dwelling B (label C).

UHASSELT
KNOWLEDGE IN ACTION

Conclusions

Experimental conditions - E energy label

UHASSELT

Conclusions

Interpretation of the EPC score

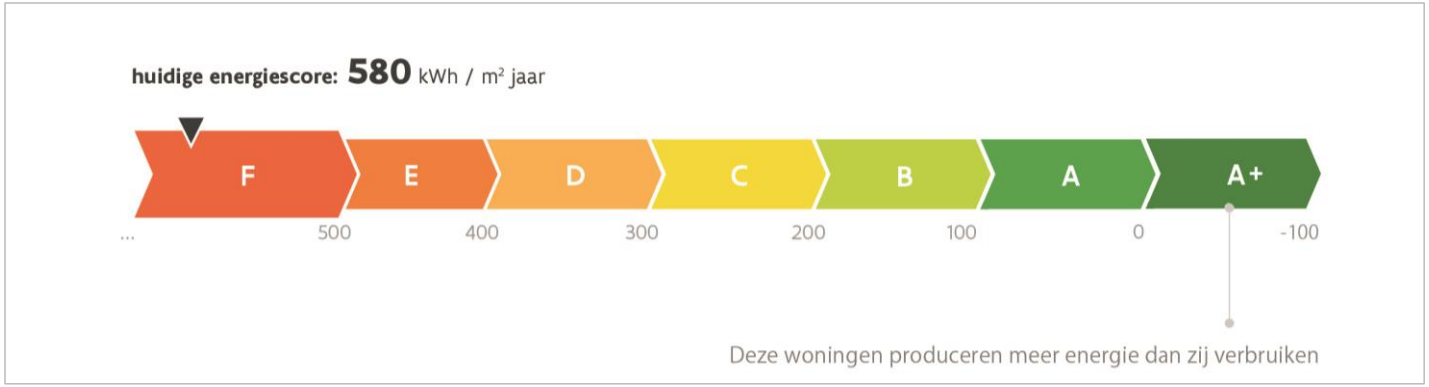
- 72% of respondents are not aware that the EPC score is relative to the size of the dwelling
  - The total energy primary should be mentioned (kWh per year) besides the EPC score (kWh/m^2 per year)

UHASSELT
KNOWLEDGE IN ACTION

Conclusions - rescaling

- Rescaling
  - (F to A) or (F to A+) instead of (G to A)
  - Lower limit 600kWh/m^2 or higher

  - Rescaling does not affect how the dwellings in the red spectrum are assessed (there is not sensitivity between G and F buildings to be lost)
  - Rescaling contributes to a less optimistic assessment of the energy consumption of dwellings labelled C (yellow spectrum)

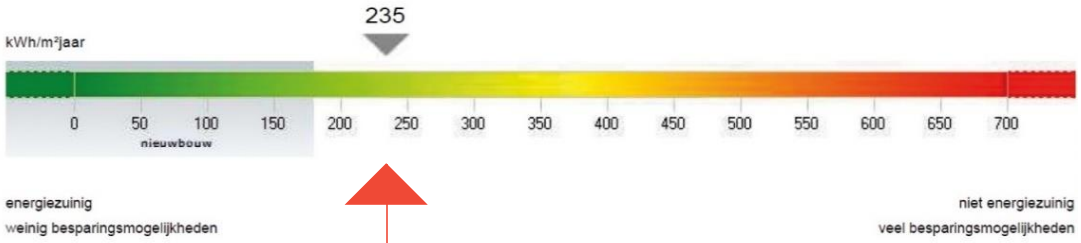


UHASSELT
KNOWLEDGE IN ACTION

Conclusions - rescaling

EPC Flanders

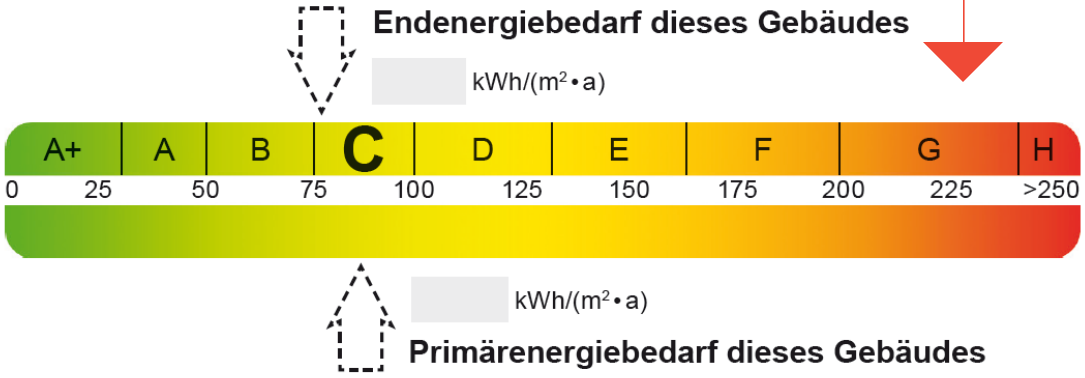
0 to 700



235 kWh/m² per year

EPC Germany

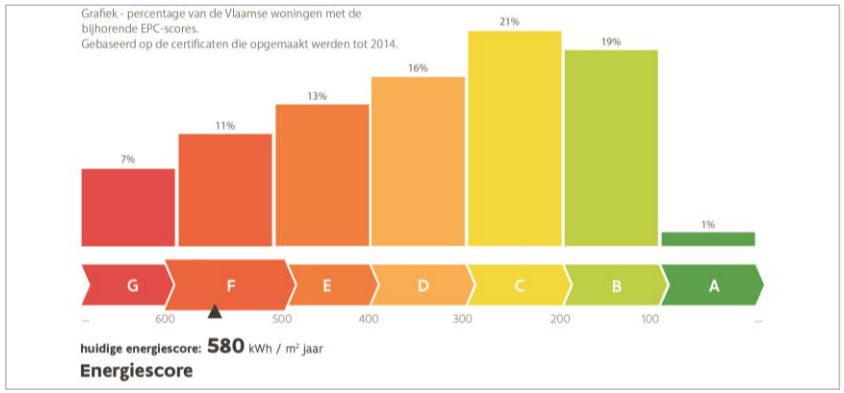
0 to 250



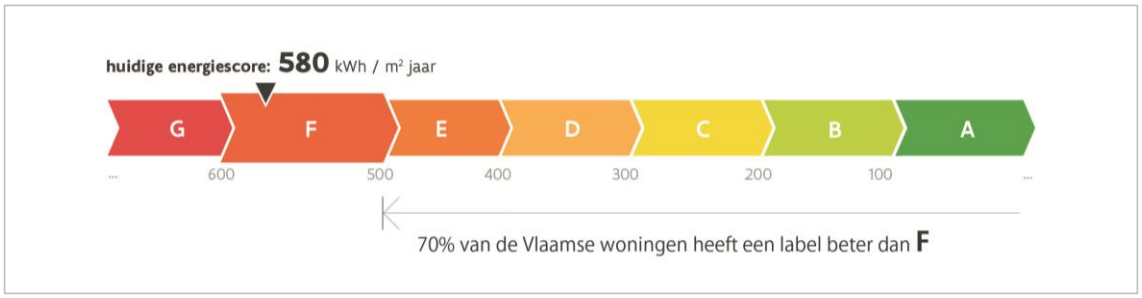
UHASSELT
KNOWLEDGE IN ACTION

Conclusions – comparison with the rest of the building stock

- Label F
  - Control version - respondents underestimate the number of dwellings with a better label
  - Showing a graph is more effective than writing the percentage as plain text



E8 – graph building stock



E3 – text, % better label

UHASSELT
KNOWLEDGE IN ACTION

Thank you for your attention!

victoria.taranu@uhasselt.be
ResearchGate
https://www.researchgate.net/profile/Victoria_Taranu

UHASSELT

Energy label – Percentage performing better than dwelling C

Percentage of the dwellings performing better than dwelling C per 10 experimental conditions of the energy label

- E1 – VEA clean
- E2 – VEA control condition
- E10 – VEA average same type
- E3 – text % better label
- E4 – text median building stock
- E5 – rescale F to A
- E6 – rescale F to A+, text A+
- E7 – text total energy
- E8 – graph building stock
- E9 – building stock, 3 steps

UHASSELT
KNOWLEDGE IN ACTION

Energy label – Percentage performing better than dwelling C

Percentage of the dwellings performing better than dwelling C per 10 experimental conditions of the energy label

	E1	E10	E2	E3	E4	E5	E6	E7	E8	E9
Mean 35.04	37.73	31.3	31.6	28	38.1	38.89	41.25	35.65	33.6	34.78

Actually 20%

ANOVA Kruskal-Wallis

chi-squared	df	p-value
14.208	9	0.1151

- Not significant

- E1 – VEA clean
- E2 – VEA control condition
- E10 – VEA average same type
- E3 – text % better label
- E4 – text median building stock
- E5 – rescale F to A
- E6 – rescale F to A+, text A+
- E7 – text total energy
- E8 – graph building stock
- E9 – building stock, 3 steps

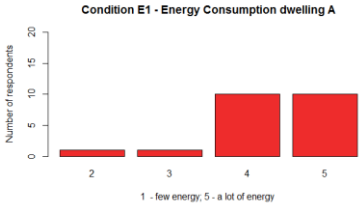
UHASSELT
KNOWLEDGE IN ACTION

Energy label - Perceived energy consumption dwelling A

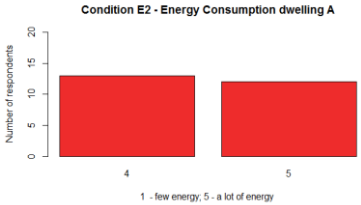
ANOVA check for normal distribution and homogeneity of variances

Perceived Energy consumption - Dwelling A

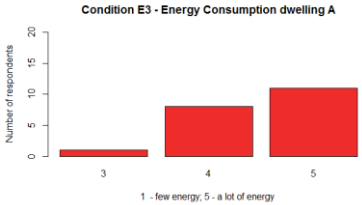
per 10 experimental conditions of the energy indicator



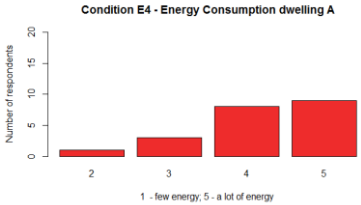
E1



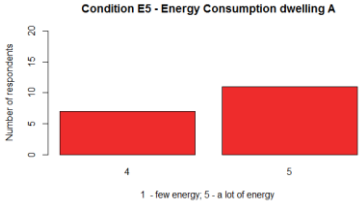
E2



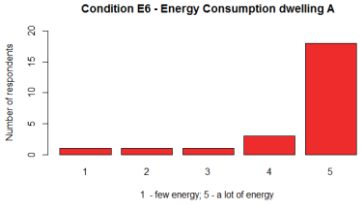
E3



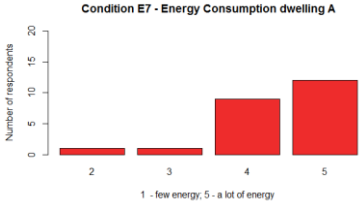
E4



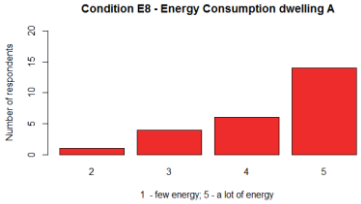
E5



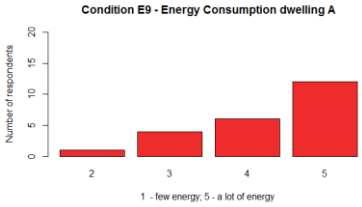
E6



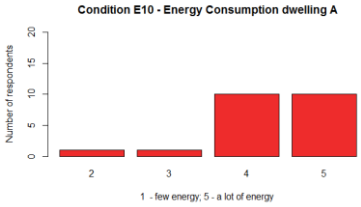
E7



E8



E9



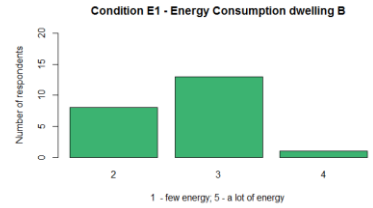
E10

UHASSELT

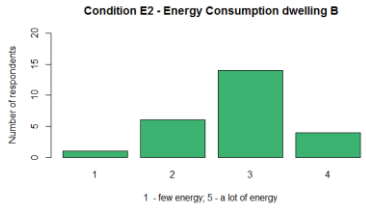
KNOWLEDGE IN ACTION

Energy label - Perceived Energy Consumption dwelling B

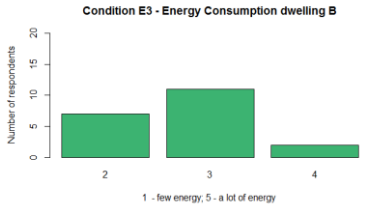
Perceived Energy Consumption - Dwelling B
per 10 experimental conditions of the energy indicator



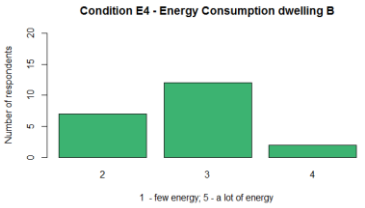
E1



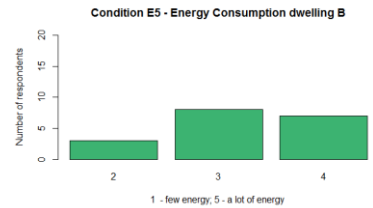
E2



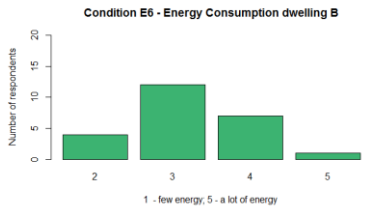
E3



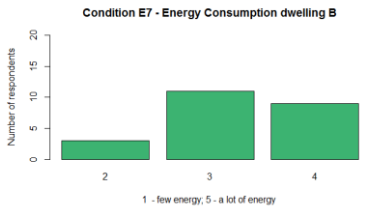
E4



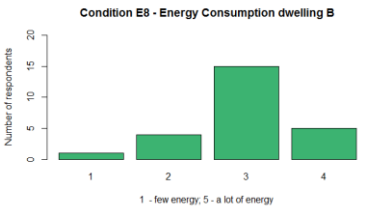
E5



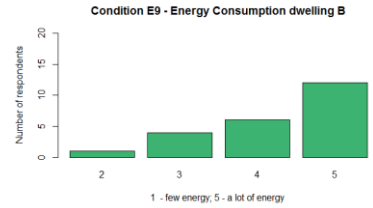
E6



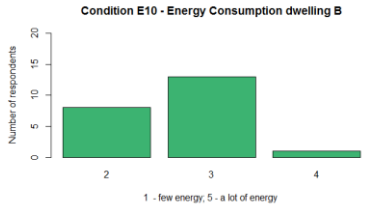
E7



E8



E9

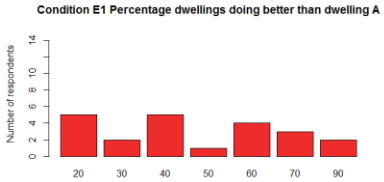


E10

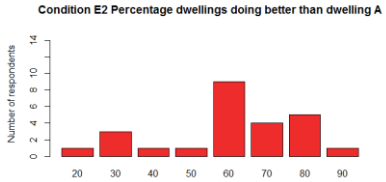
UHASSELT
KNOWLEDGE IN ACTION

Energy label – Percentage performing better than dwelling F

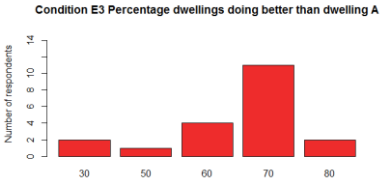
Percentage of the dwellings performing better than dwelling F
per 10 experimental conditions of the energy indicator



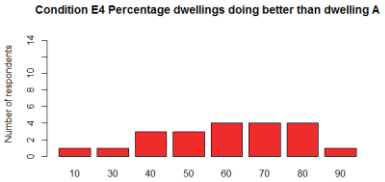
E1



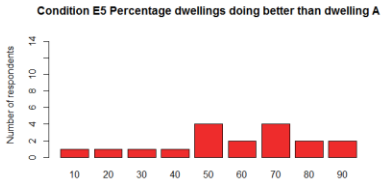
E2



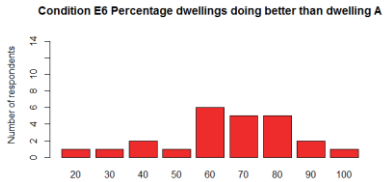
E3



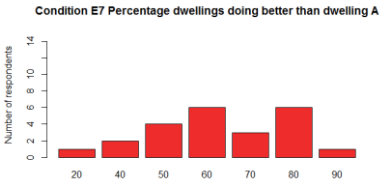
E4



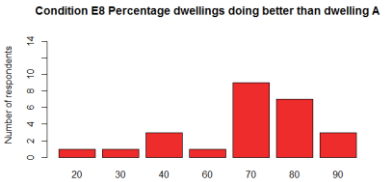
E5



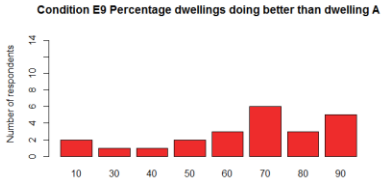
E6



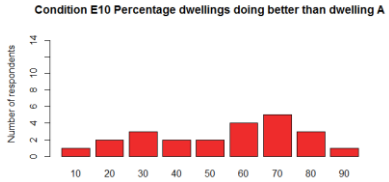
E7



E8



E9



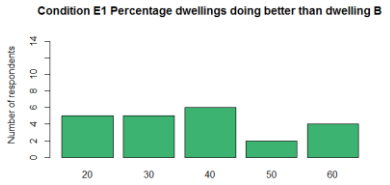
E10

- Analysis of variance yet to be done

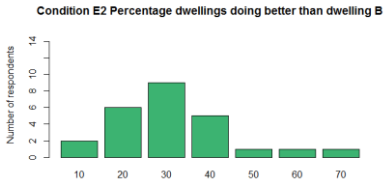
UHASSELT
KNOWLEDGE IN ACTION

Energy label – Percentage performing better than dwelling C

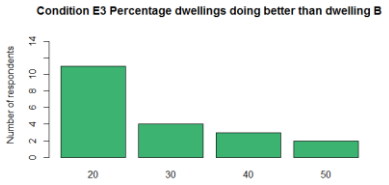
Percentage of the dwellings performing better than dwelling C
per 10 experimental conditions of the energy indicator



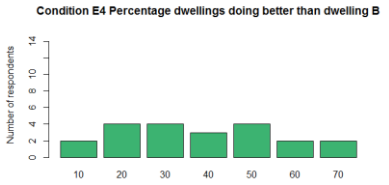
E1



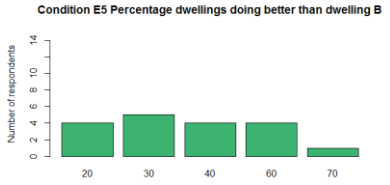
E2



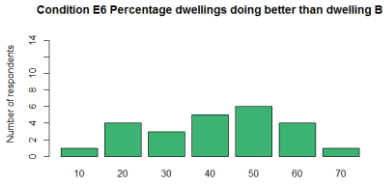
E3



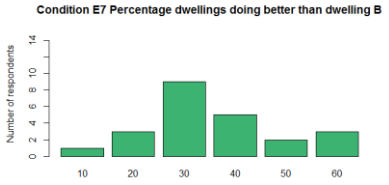
E4



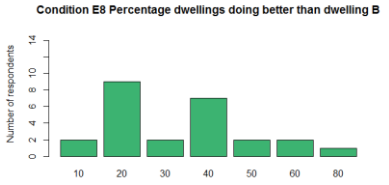
E5



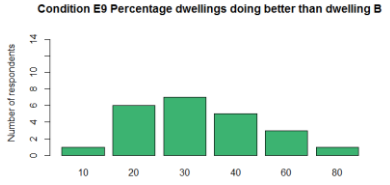
E6



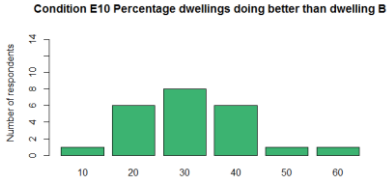
E7



E8



E9



E10

- Analysis of variance yet to be done

UHASSELT
KNOWLEDGE IN ACTION

Comparative analysis EPCs

- Two types of EPCs
  - First assessment NL
  - Detailed and technical information DE

		DE	NL	UK	ES	RO	DK	FR	Lombardy	Flanders
Number of pages		5	1	4	7	6	14	4	2	5
Online version		-	✓	✓	-	-	✓	-	✓	-
Photo of the dwelling		✓	-	-	✓	-	✓	-	-	✓
Site plan		-	-	-	✓	-	-	-	✓	-
Energy rating	Label	✓	✓	✓	✓	✓	✓	✓	✓	-
	Scale	✓	-	-	-	-	-	-	-	✓
	Type of indicator	primary energy	-	EE	CO2	final energy	-	primary energy	primary energy	primary energy
	Units	kWh/ m^2 per year	-	-	kg $CO2/m^2$ per year	kWh/ m^2 per year	-	kWh/ m^2 per year	kWh/ m^2 per year	kWh/ m^2 per year
CO2 emissions label		-	-	✓	✓	-	-	✓	✓	✓
Assessment of recommendations		✓	-	✓	✓	-	✓	✓	✓	-

UHASSELT
KNOWLEDGE IN ACTION

Comparative analysis EPCs

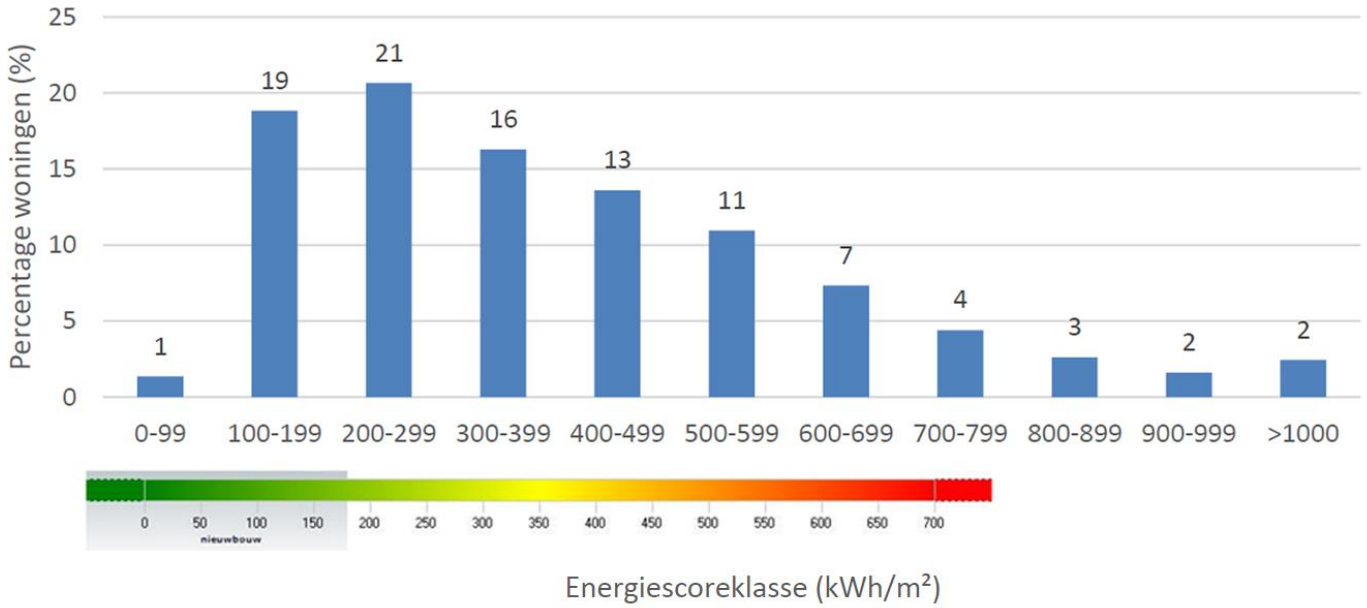
- Potential nudges

		DE	NL	UK	ES	RO	DK	FR	Lombardy	Flanders
First Degree Nudge	Make it easy	-	✓	✓	-	-	✓	✓	✓	-
	Make it salient	✓	-	✓	-	✓	✓	✓	✓	-
Second Degree Nudge	Social norm	✓	✓	-	-	-	✓	-	-	-
	Temporal discounting	✓	-	✓	✓	-	-	✓	✓	-
	Default	-	✓	✓	-	-	✓	-	-	-
Third Degree Nudge	Anchoring	✓	✓	✓	-	-	✓	-	✓	✓

UHASSELT
KNOWLEDGE IN ACTION

‘Normal distribution’ illusion

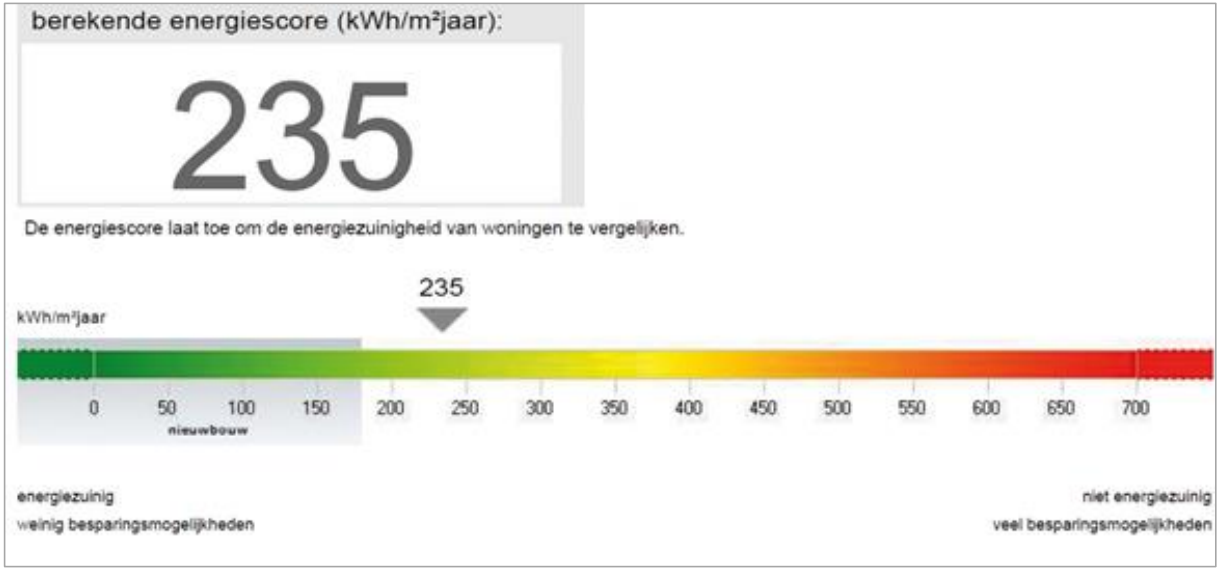
- Debate regarding the necessity to rescale the ranges and the colours of the continuous scale
- Clues regarding a possible normal distribution bias
  - overestimation of the energy performance of a certain dwelling by underestimating the performance of the rest of the dwelling stock



Distribution of the dwellings according to the EPC score **(VERBEECK & CEULEMANS, 2015)** and the scale of the energy indicator. Data up to 2014

UHASSELT
KNOWLEDGE IN ACTION

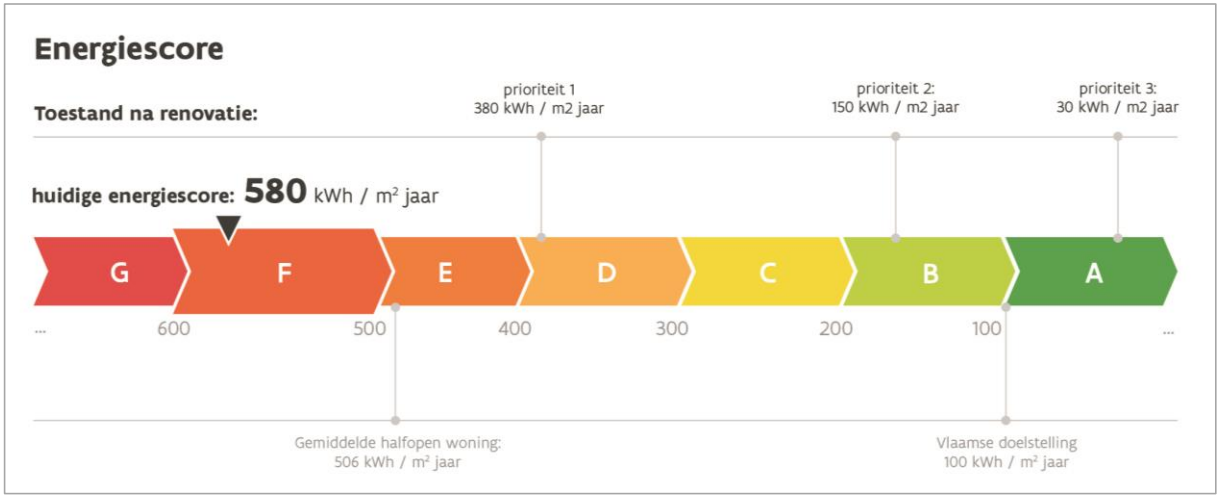
EPC Flanders - Energy performance indicator



Existing version

- energy score
- continuous scale

0 to 700



New version VEA

- Label
- Energy score
- Continuous scale

700 to 0

UHASSELT
KNOWLEDGE IN ACTION

Recommendations

Aanbevelingen voor de verbetering van de isolatie van het hellende dak

Aanbeveling: plaats (extra) isolatie in het hellende dak

58,5 m² hellend dak is onvoldoende geïsoleerd.

Door het hellende dak (bijkomend) te isoleren, zal het energieverbruik verminderen. Een energiezuinig dak heeft een U-waarde die kleiner is dan 0,4 W/m²K.

Existing version Flanders

Overzicht aanbevelingen

		HUIDIGE SITUATIE	AANBEVELING	PRIJSSCHATTING	LABEL NA RENOVATIE
1		**Ramen** Er is momenteel nog overal enkele beglazing aanwezig	Plaats nieuw schrijnwerk met hoogrendements beglazing	€ 8000 - € 12 000	D
		Verwarming Ketel is sterk verouderd en niet energiezuinig.	Plaats een efficiënt verwarmingssysteem	€ 4500 - € 6500	D

New version VEA

PROTOTYPE