

TRIAS CLIMATICA

ACCELERATING CLIMATE TRANSITION IN EXISTING BUILDING STOCK

OPTIMIZED

IVAN PIETTE

WHO IS?

- Ivan Piette
- Engineer thermodynamics
- > 30 year active in HVAC
 - Technical instructor
 - Engineer in HVAC engineering office
 - Manager purchase HVAC installations
 - Manager maintenance HVAC installations
 - Technical director
 - Head aftersales department
 - Head product management
- EPC expert (Flanders)
- Member norm commissions
- Active in several professional associations (ATIC, ATTB, ...)



- What it's all about:

- accelerating CO2 reduction
- use of government tools
- climate change
- maximising CO2 reduction

- What it's not about

- economic analyses
- OPEX (the times, they are a-changing)
- financial opportunities
- TCO

PROGRAMM

1. Easy tools to understand climate change
2. EU goals and time lines
3. EU goals and focus
4. How do we plan to do it?
5. Speeding-up Climate change needs a Mind change
6. How to speed-up?
7. Focus on the heat generator
8. What's in it for climate?
9. What's in it for the owner?
10. Yes we can!
11. Trias Climatica advantages

PROGRAMM

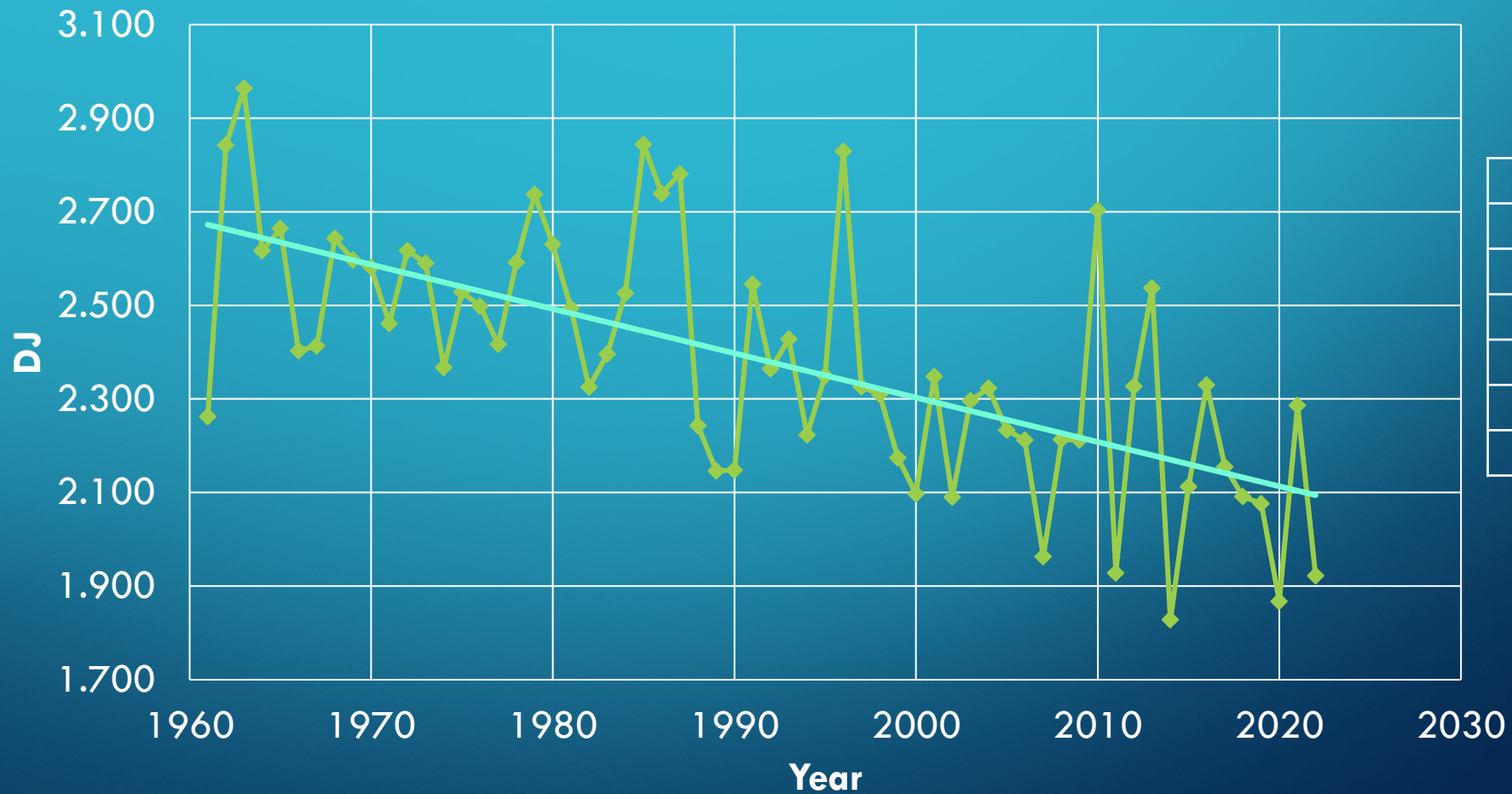
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CLIMATE CHANGE – EASY TOOLS TO UNDERSTAND

GD-DJ

$$y = -9,4768x + 21256$$

$$R^2 = 0,4351$$



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CLIMATE CHANGE – EU GOALS AND TIME LINES

2030 climate and energy framework - key targets

- Greenhouse gas emissions: from 40% to at least 55% reduction (compared to 1990 levels)
- Renewable energy: from 32% to 42.5% share
- Energy efficiency target for final energy consumption: from 32.5% to 36%
- Energy efficiency target for primary energy consumption: 39%

Source: https://climate.ec.europa.eu/eu-action/climate-strategies-targets/2030-climate-energy-framework_en#greenhouse-gas-emissions---raising-the-ambition

CLIMATE CHANGE – EU GOALS AND TIME LINES

2050 long-term strategy

- The EU aims to be climate-neutral by 2050 – an economy with net-zero greenhouse gas emissions. This objective is at the heart of the European Green Deal and in line with the EU's commitment to global climate action under the Paris Agreement.
- The Commission's vision covers nearly all EU policies and is in line with the Paris Agreement objective to keep the global temperature increase to well below 2°C and pursue efforts to keep it to 1.5°C.
- As part of the European Green Deal, the Commission proposed on 4 March 2020 the first European Climate Law to enshrine the 2050 climate-neutrality target into law.

Source: https://climate.ec.europa.eu/eu-action/climate-strategies-targets/2050-long-term-strategy_en

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CLIMATE CHANGE – EU GOALS AND FOCUS

The national plans outline how the EU countries intend to address the 5 dimensions of the energy union:

- decarbonisation
- energy efficiency
- energy security
- internal energy market
- research, innovation and competitiveness

Source: https://commission.europa.eu/energy-climate-change-environment/implementation-eu-countries/energy-and-climate-governance-and-reporting/national-energy-and-climate-plans_en

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CLIMATE CHANGE – HOW DO WE PLAN TO DO IT?

To reach the goal of (buildings) zero carbon emissions in 2050:

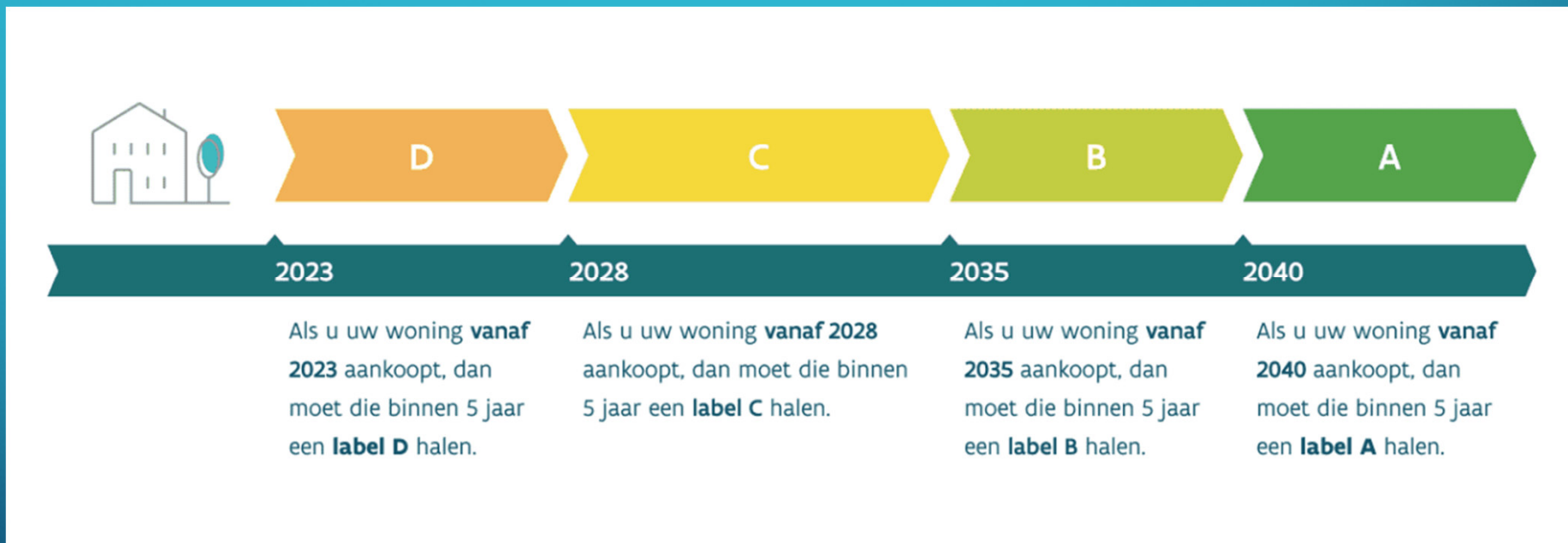
- To reach 100% A-label buildings in 2050, the yearly renovation rate should be $\geq 3,5\%$ (actually 8% has label A in Flanders)

Start in	Yearly renovation %	Duration for 100%	Ends up in
2024	3,5%	26	2050
2025	3,7%	25	2050
2026	3,8%	24	2050
2027	4,0%	23	2050
2028	4,2%	22	2050
2029	4,4%	21	2050
2030	4,6%	20	2050

- Actually, the Belgian yearly renovation rate $< 1\%$

CLIMATE CHANGE – HOW DO WE PLAN TO DO IT?

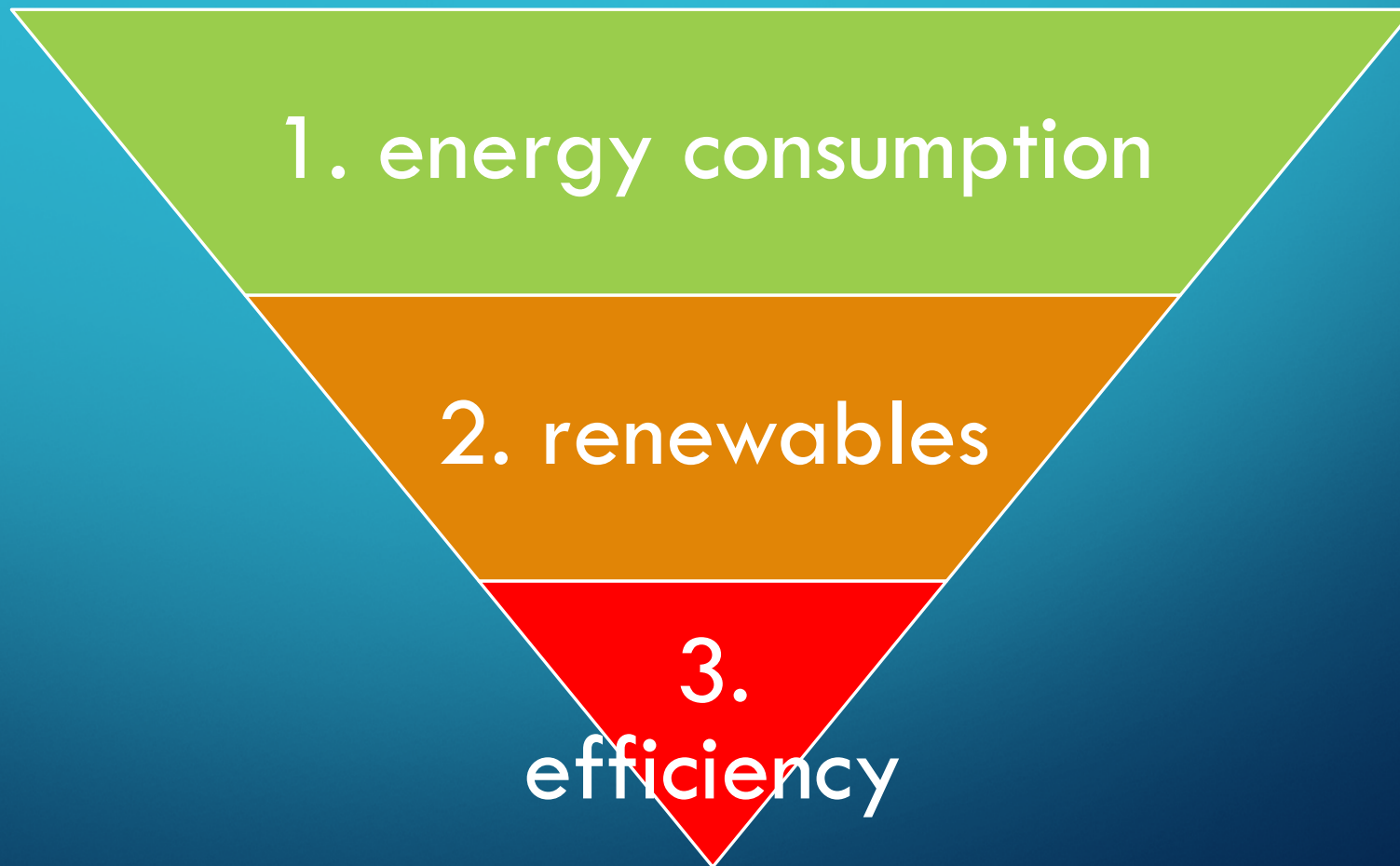
Flanders approach on renovation targets



Source: <https://www.vlaanderen.be/een-huis-of-appartement-kopen/renovatieverplichting-voor-residentiele-gebouwen>

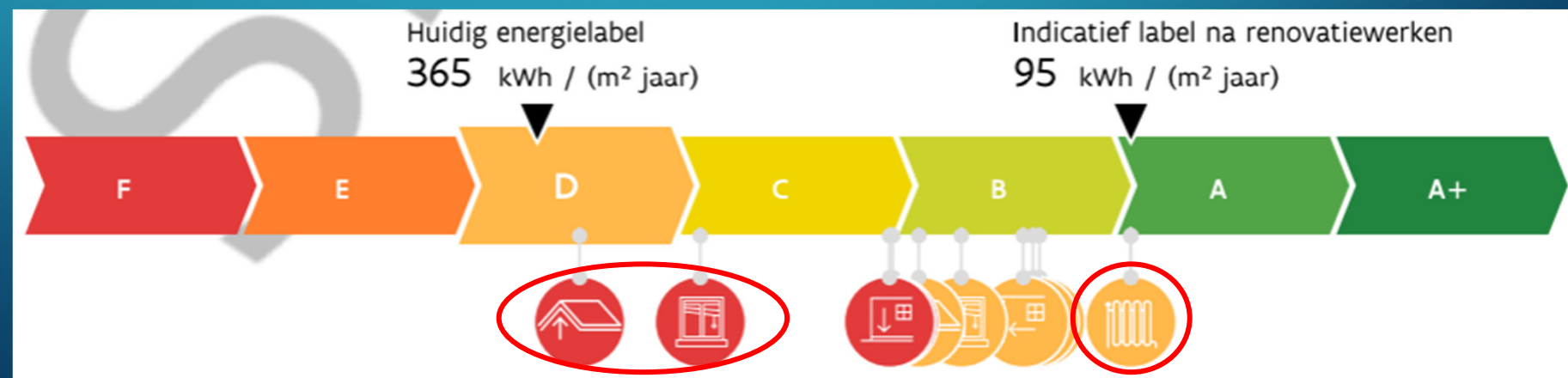
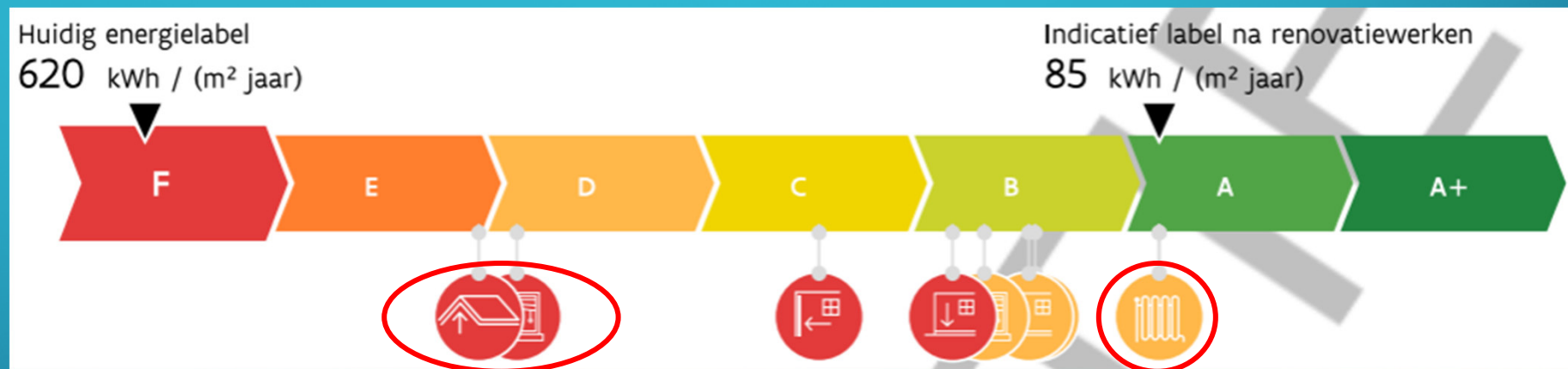
CLIMATE CHANGE – HOW DO WE PLAN TO DO IT?

Principle of the Trias Energetica



CLIMATE CHANGE – HOW DO WE PLAN TO DO IT?

Examples of renovation path (from EPC Flanders)



CLIMATE CHANGE – HOW DO WE PLAN TO DO IT?

To achieve the EU targets for both 2030 and 2050

- Concentrating on the building envelope is too slow
- Concentrating on the energy consumption is too slow

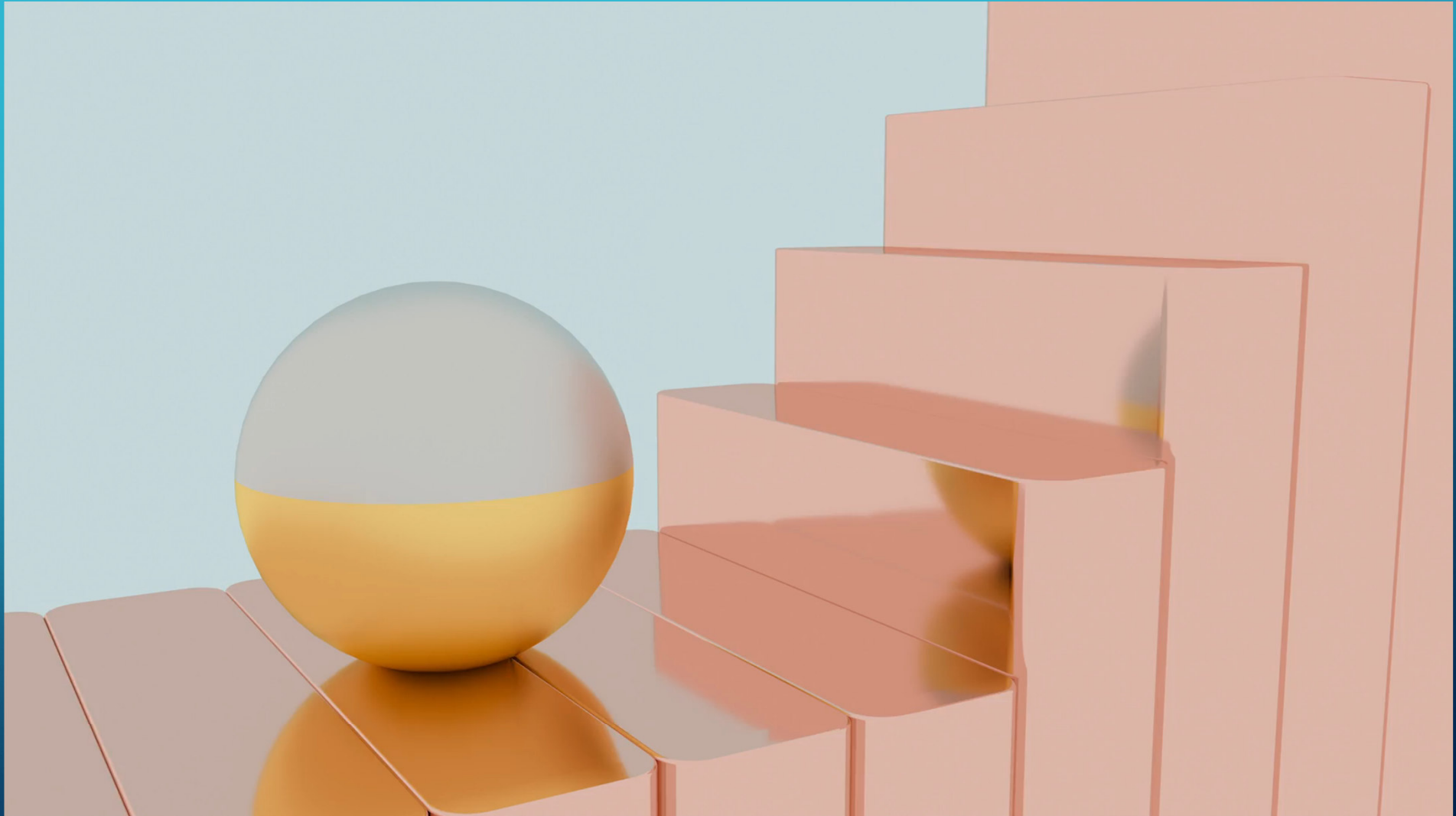
There's need for speed when it comes to climate change!

But is there another way to speed up the transition?

PROGRAMM

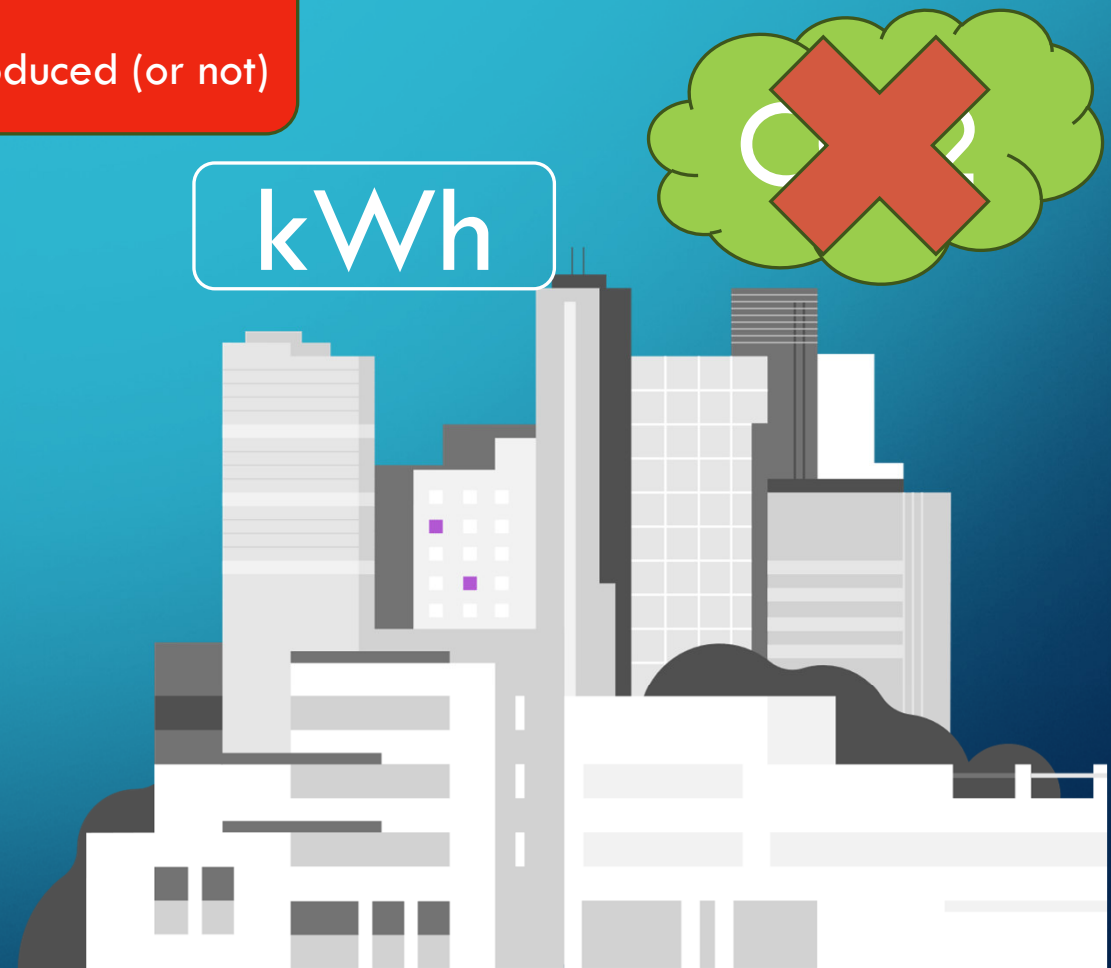
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SPEEDING-UP CLIMATE CHANGE NEEDS A MIND CHANGE

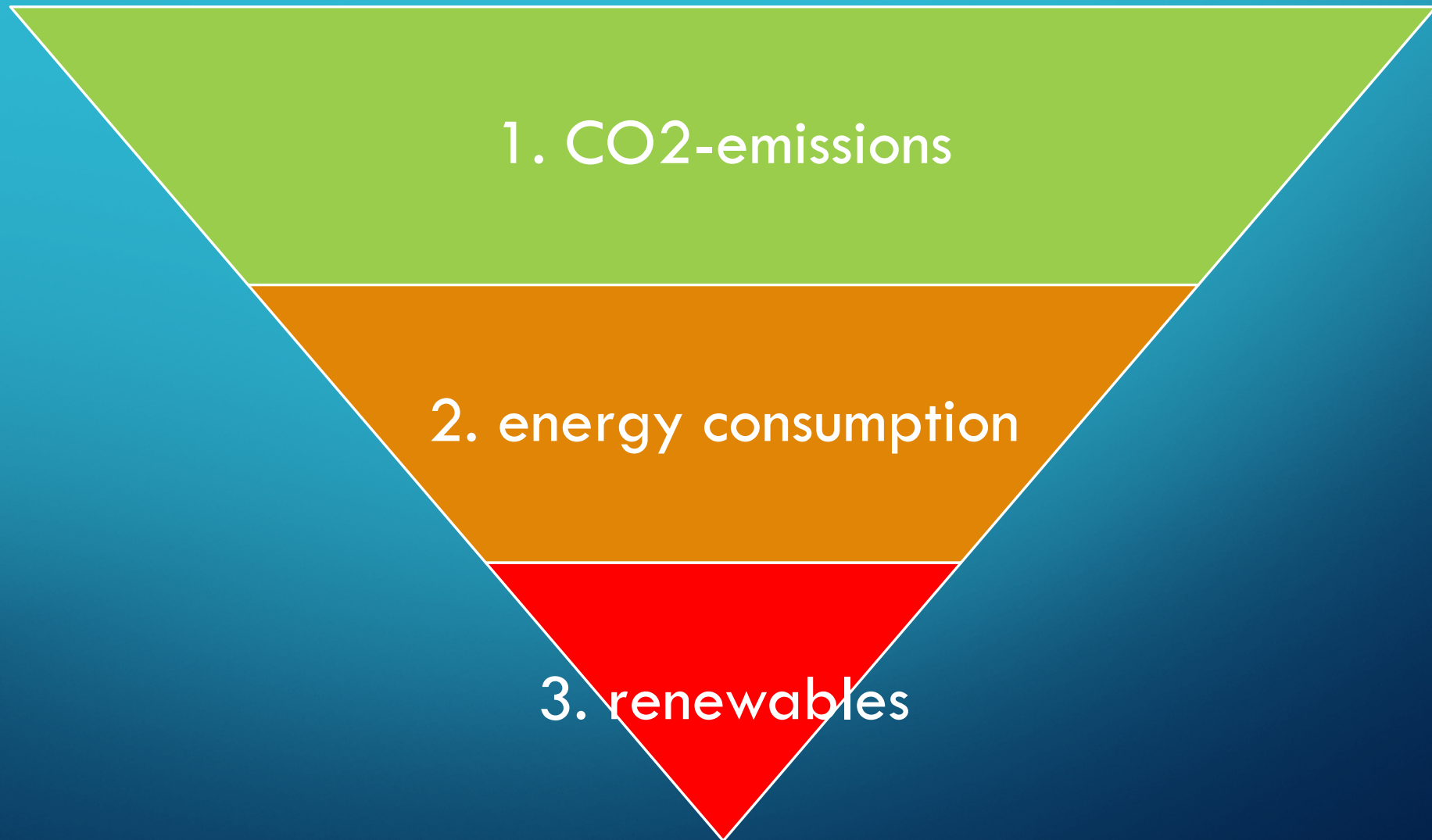


SPEEDING-UP CLIMATE CHANGE NEEDS A MIND CHANGE

Buildings only determine the energy demand
Heat generators determine whether CO₂ is produced (or not)



SPEEDING-UP CLIMATE CHANGE NEEDS A MIND CHANGE



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CLIMATE CHANGE – HOW TO SPEED-UP?

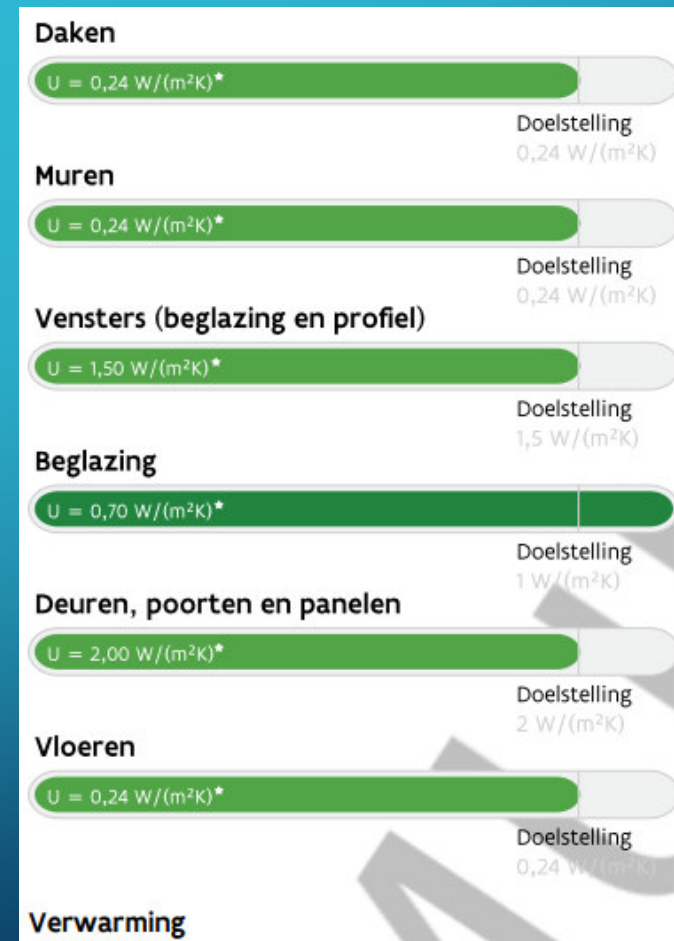
- Analysis based on the EPC-tool of Flanders and its default values ([Energieprestatiedatabank](#))
- Three building types with different performances (random selection)
 - Semi-detached house – renovated 1976 – electrical storage heating (1.020.572)
 - Terraced house – not renovated – gas non-condensing - radiators (1.336.745)
 - Single family house – build 1992 – oil non-condensing – radiators (1.448.408)
- Simulation of the individual renovation steps and some of their combinations towards 2050 goal (label A)
- Focus = Climate Change = CO2 reduction/neutrality

Source: [Gebouwenpark | Statbel \(fgov.be\)](#)

CLIMATE CHANGE – HOW TO SPEED-UP?





We went from « as is »

to « goals 2050 »



CLIMATE CHANGE – HOW TO SPEED-UP?

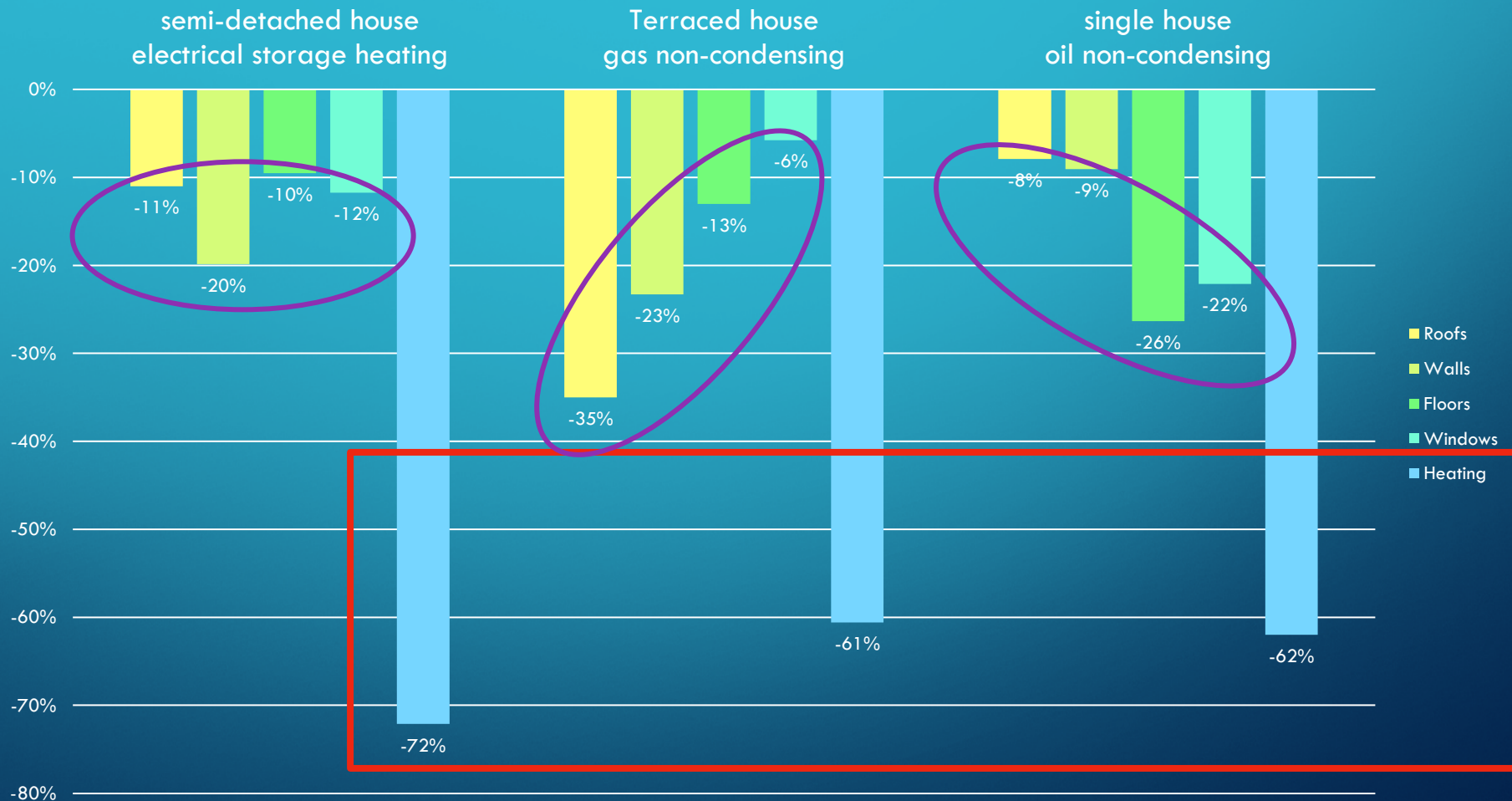
We took into account these expenses and always the cheapest one

	HUIDIGE SITUATIE	AANBEVELING	GEMIDDELDE PRIJSINDICATIE ★
	Plafond 45 m ² van het plafond is vermoedelijk te weinig geïsoleerd.	Plaats bijkomende isolatie in of onder het plafond of plaats bijkomende isolatie boven op het plafond.	€ 7 000★ € 4 000★
	Dakvensters en koepels 26 m ² van de dakvlakvensters of koepels heeft polycarbonaatplaten. Dat is niet energiezuinig. Ook de profielen zijn thermisch weinig performant.	Plaats nieuwe dakvlakvensters of koepels met hoogrendementsbeglazing en energieperformante raamprofielen	€ 18 500★
	Panelen 0,8 m ² van de panelen is onvoldoende geïsoleerd.	Vervang de panelen door energiezuinige vulpanelen met sterk isolerende profielen.	€ 500★
	Vloer boven kelder of buiten 90 m ² van de vloer is niet geïsoleerd.	Plaats isolatie.	€ 18 500★
	Hellend dak 36 m ² van het hellende dak is vermoedelijk te weinig geïsoleerd.	Plaats bijkomende isolatie aan de binnenkant van het hellende dak of plaats bijkomende isolatie aan de buitenkant van het hellende dak.	€ 2 500★ € 12 000★

Source: <https://www.vlaanderen.be/epc-voor-een-residentiele-eeheid/uitleg-bij-de-onderdelen-van-het-epc-residentiele-eeheid#gemiddelde-prijsindicaties-bij-woningen>

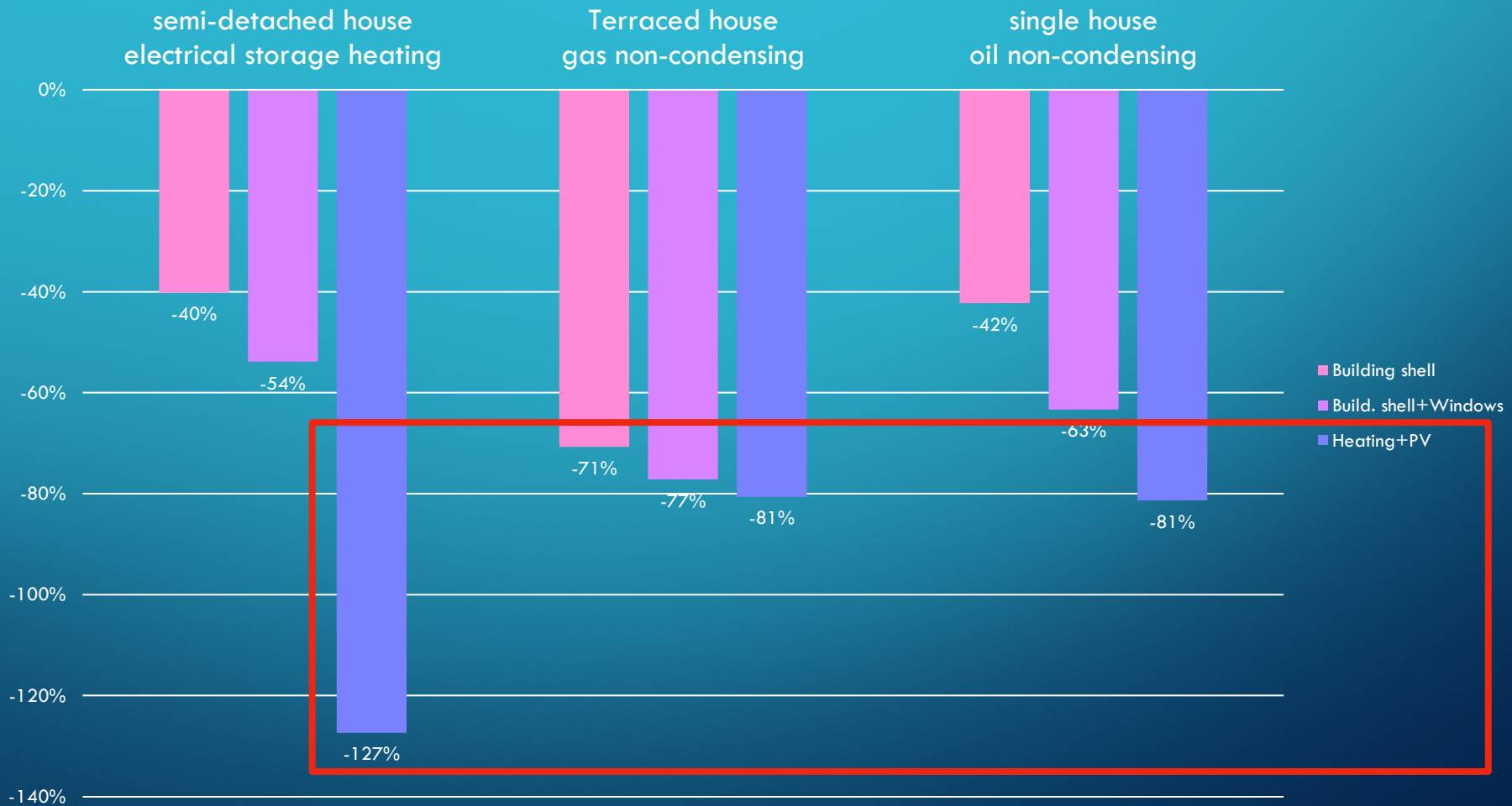
CLIMATE CHANGE – HOW TO SPEED-UP?

Individual renovation steps - CO2 reduction



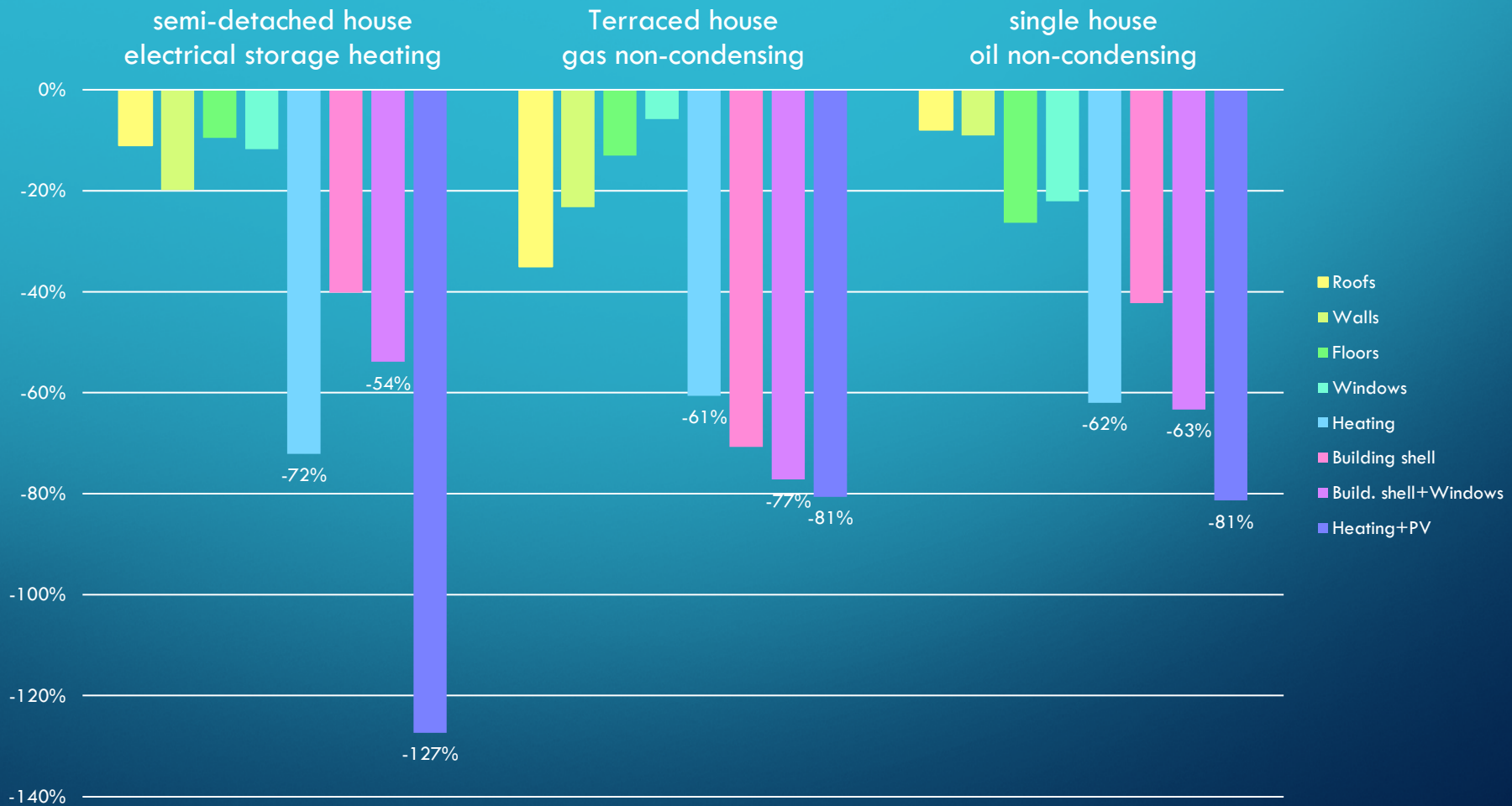
CLIMATE CHANGE – HOW TO SPEED-UP?

Combined renovation steps - CO2 reduction



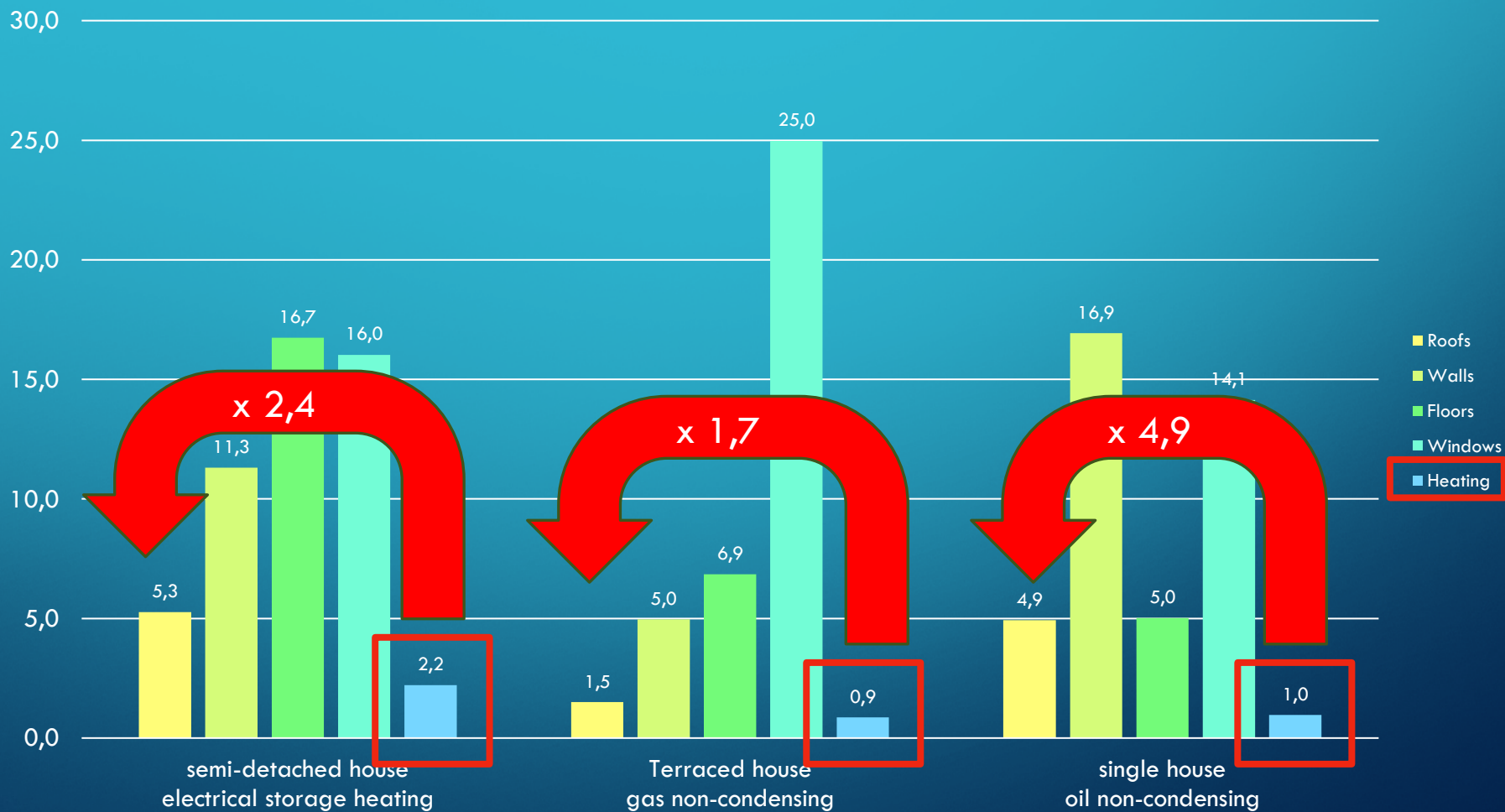
CLIMATE CHANGE – HOW TO SPEED-UP?

Renovation steps overview - CO2 reduction

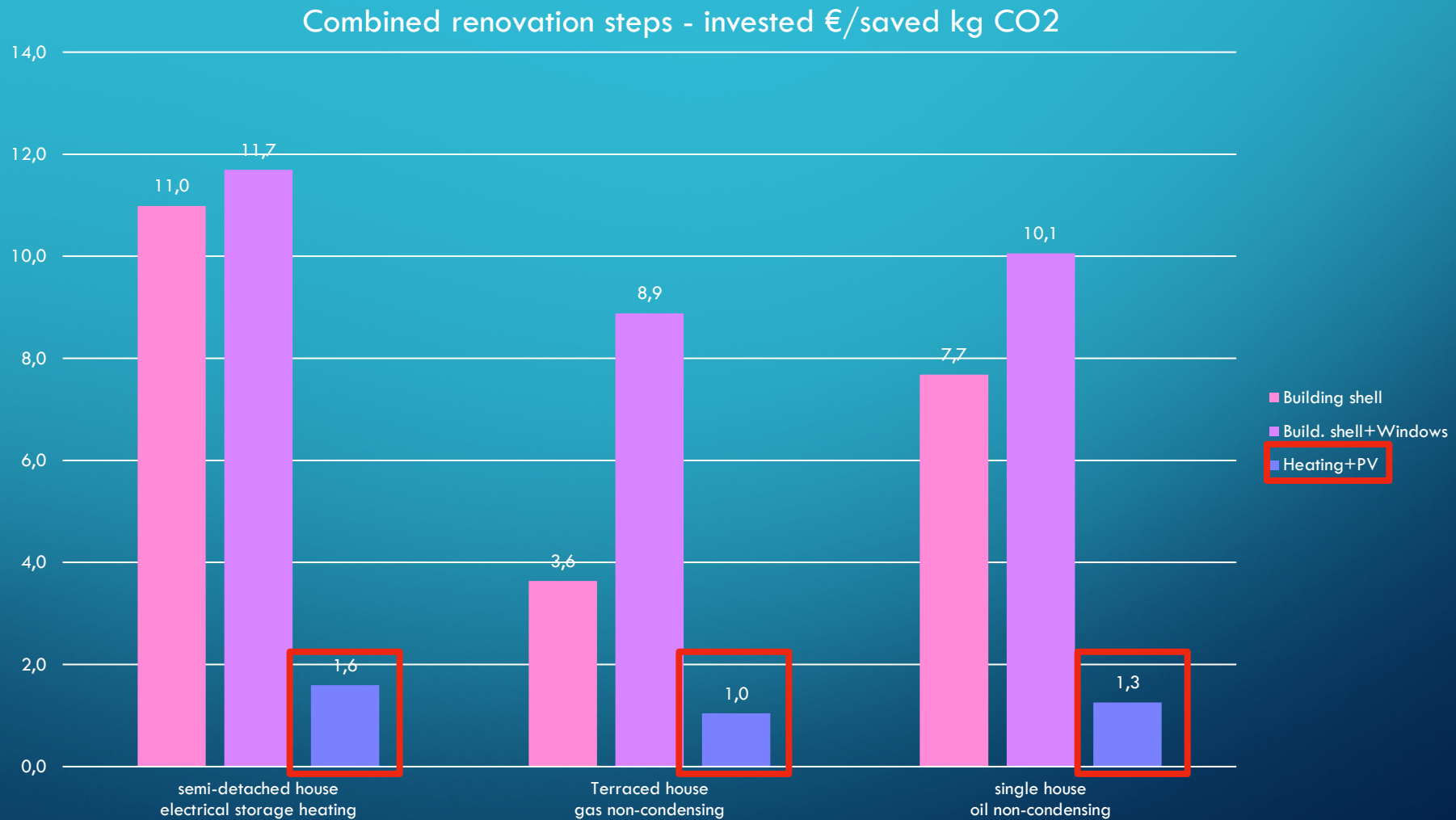


CLIMATE CHANGE – HOW TO SPEED-UP?

Individual renovation steps – invested €/saved kg CO2

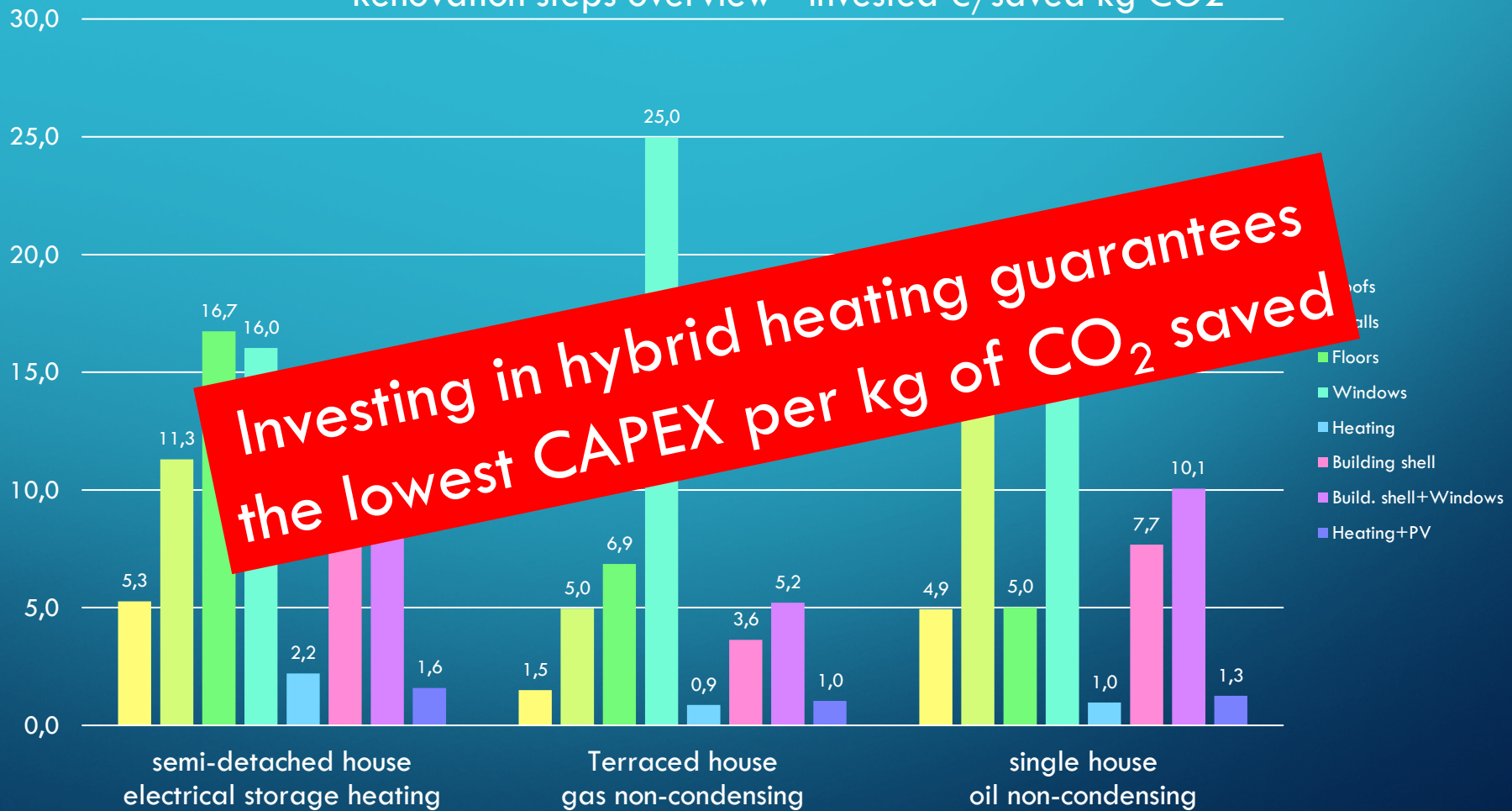


CLIMATE CHANGE – HOW TO SPEED-UP?



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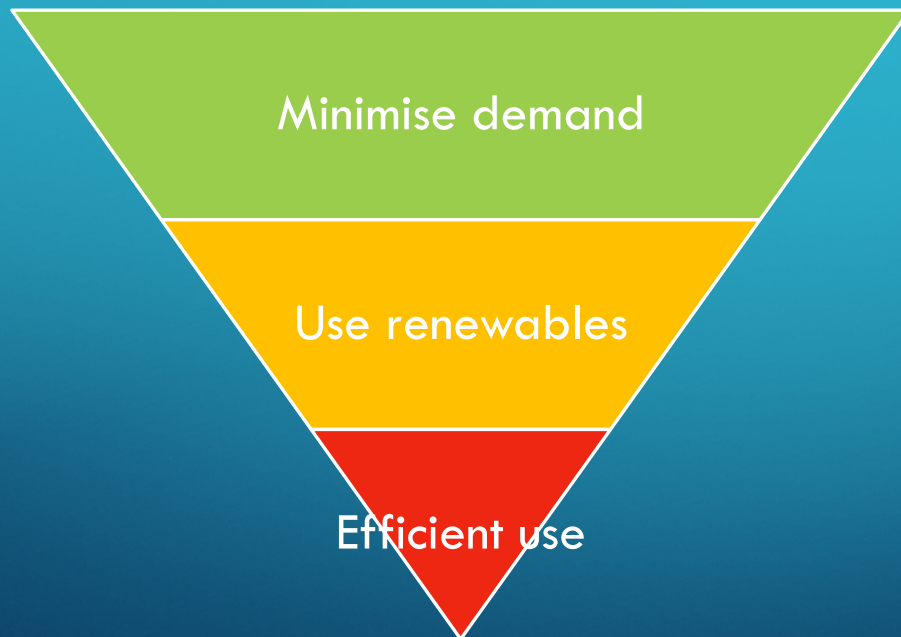
Renovation steps overview - invested €/saved kg CO₂



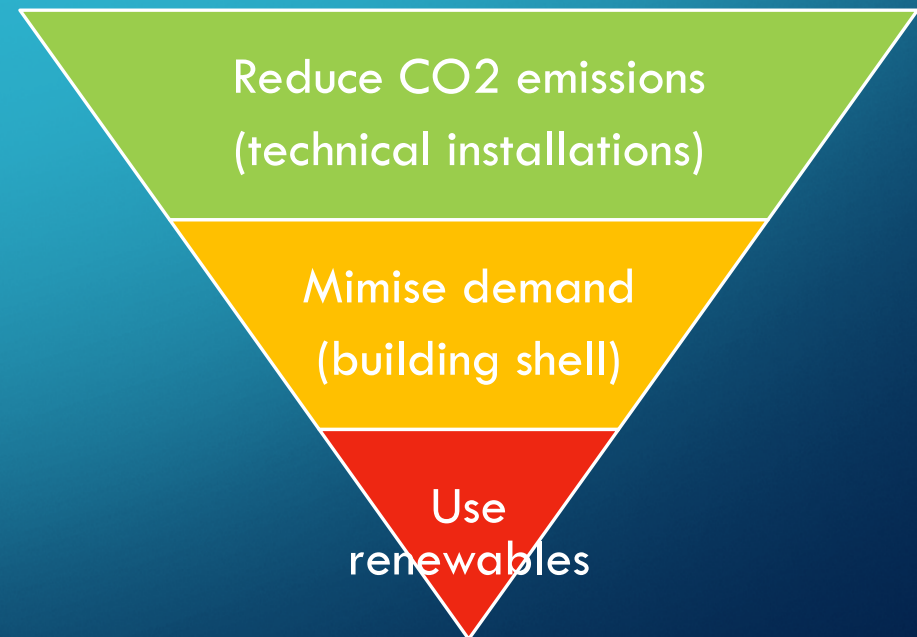
Investing in hybrid heating guarantees the lowest CAPEX per kg of CO₂ saved

CLIMATE CHANGE – HOW TO SPEED-UP?

WE KNOW THIS TRIAS ENERGETICA



IT MUST BECOME THIS TRIAS CLIMATICA



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CLIMATE CHANGE – FOCUS ON THE HEAT GENERATOR

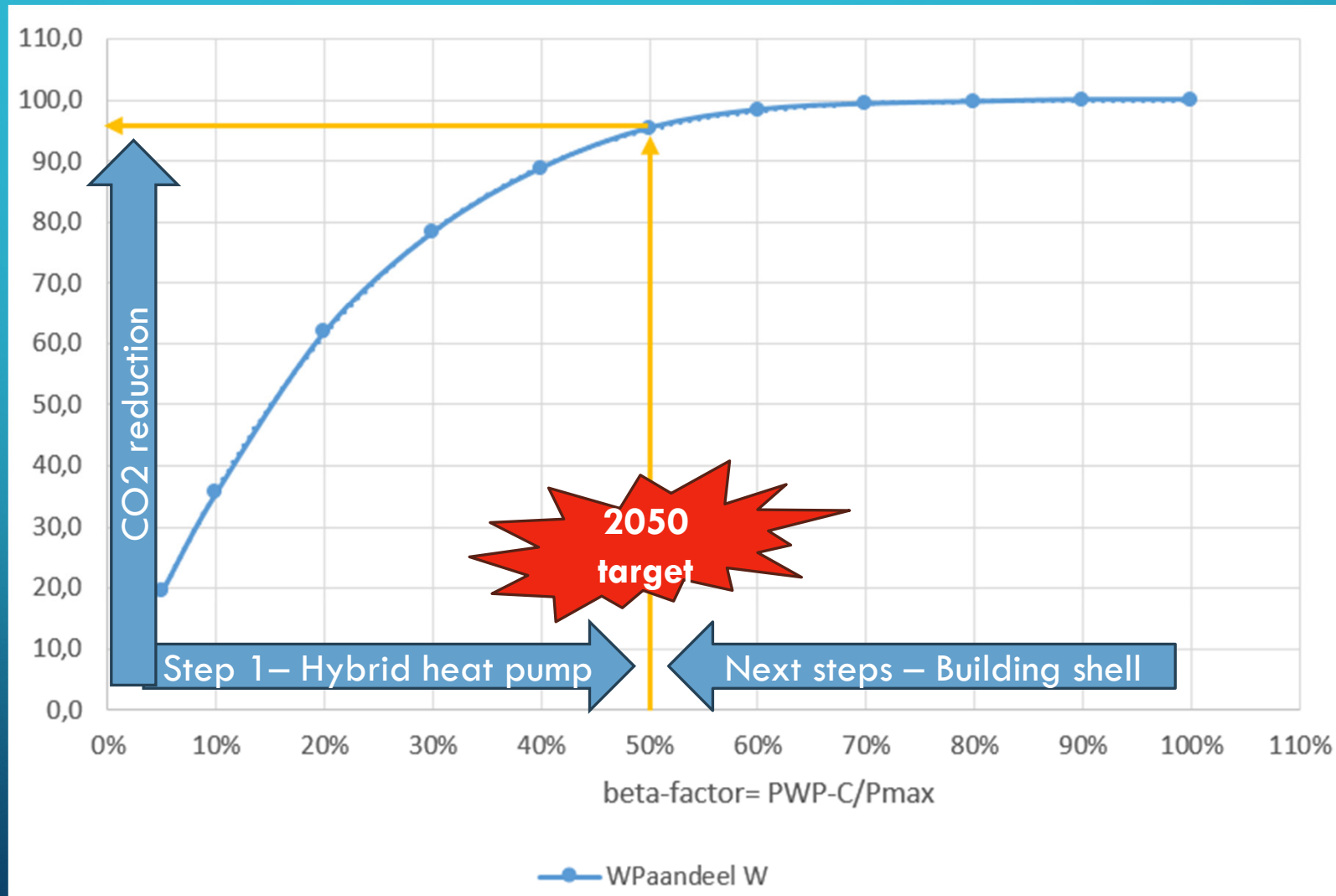
HEATING « AS IS »

- Terraced house
 - gas non-condensing
- Semi-detached house
 - electrical storage heating
- Single family house
 - oil non-condensing

HEATING « HYBRIDISATION »

- Terraced house
 - hybrid A/W heat-pump with existing boiler as back-up
- Semi-detached house
 - A/A multi-splits
- Single family house
 - hybrid A/W heat-pump with existing boiler as back-up

CLIMATE CHANGE – FOCUS ON THE HEAT GENERATOR



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CLIMATE CHANGE – WHAT’S IN IT FOR CLIMATE?

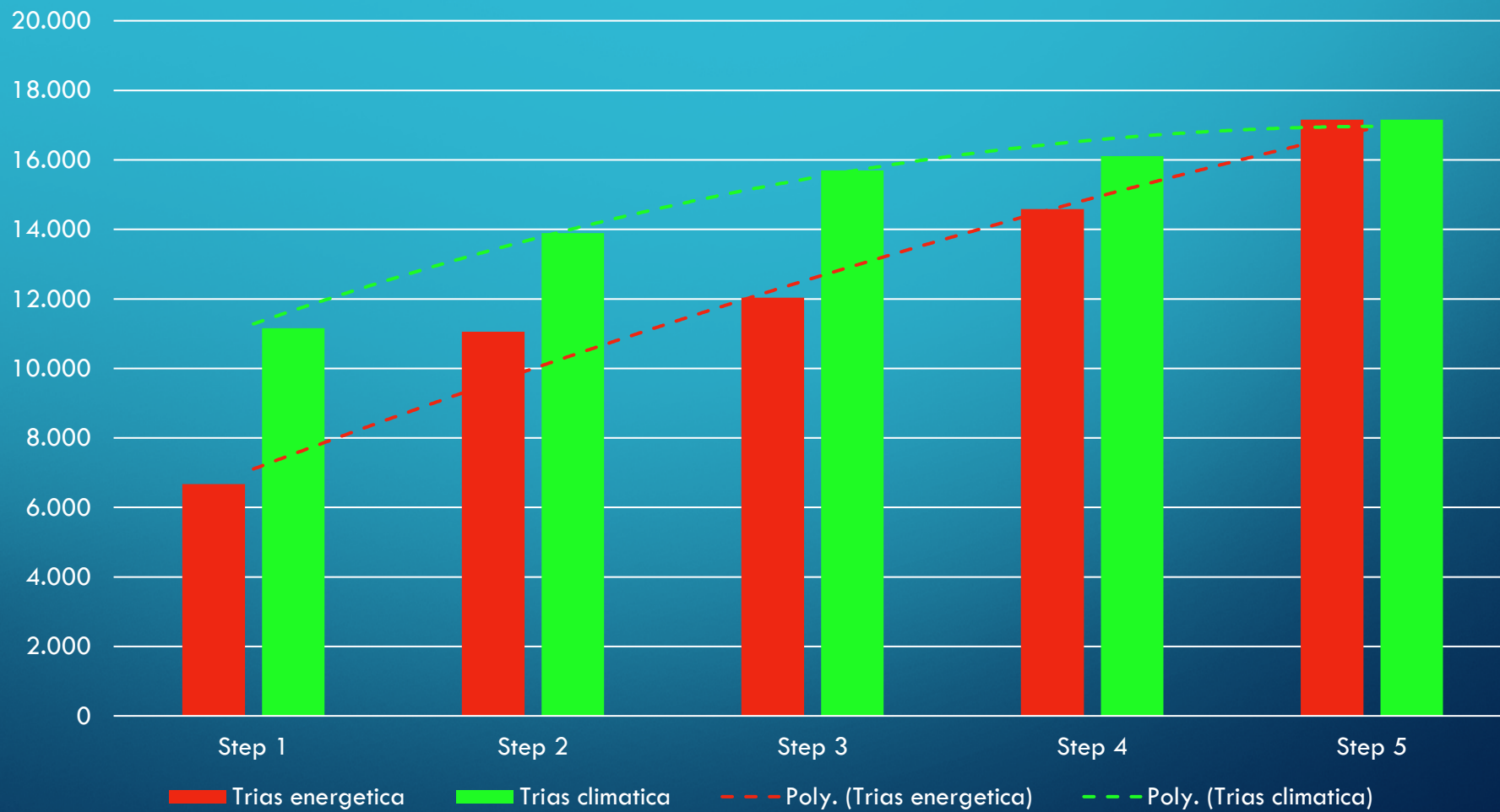
Heating	semi-detached house electrical storage heating			Terraced house gas non-condensing			Single house oil non-condensing		
	EPC value	541	151	-72,1%	620	351	-43,4%	365	248
Label	F	B		F	D		D	C	
Characteristic primary energy use (kWh/year)	103.660	28.886	-74.774	94.583	53.472	-41.111	63.560	43.267	-20.293
CO2-emission (kg/year)	13.807	3.848	-9.959	19.039	7.501	-11.538	16.640	6.323	-10.317
Indicative S-value	95	95	-	160	160	-	126	126	-
Average U-value building shell (W/m2.K)	1,07	1,07	-	2,67	2,67	-	1,67	1,67	-
Average heating efficiency (%)	88	330	275,0%	55	210	281,8%	66	211	219,7%

CLIMATE CHANGE – WHAT’S IN IT FOR CLIMATE?

	Terraced house gas non-condensing	Trias Energetica		Terraced house gas non-condensing	Trias Climatica	
		CO2 emissions	CO2 reduction		CO2 emissions	CO2 reduction
	Original situation	19.039		Original situation	19.039	
Renovation steps	Roofs	12.371	-6.668	Heating	7.883	-11.156
	Roofs+Walls	7.984	-4.387	Heating+Roofs	5.142	-2.741
	Roofs+Walls+Windows	7.004	-980	Heating+Roofs+Walls	3.338	-1.804
	Roofs+Walls+Windows+Floors	4.454	-2.550	Heating+Roofs+Walls+Windows	2.929	-409
	Roofs+Walls+Windows+Floors+Heating	1.879	-2.575	Heating+Roofs+Walls+Windows+Floors	1.879	-1.050

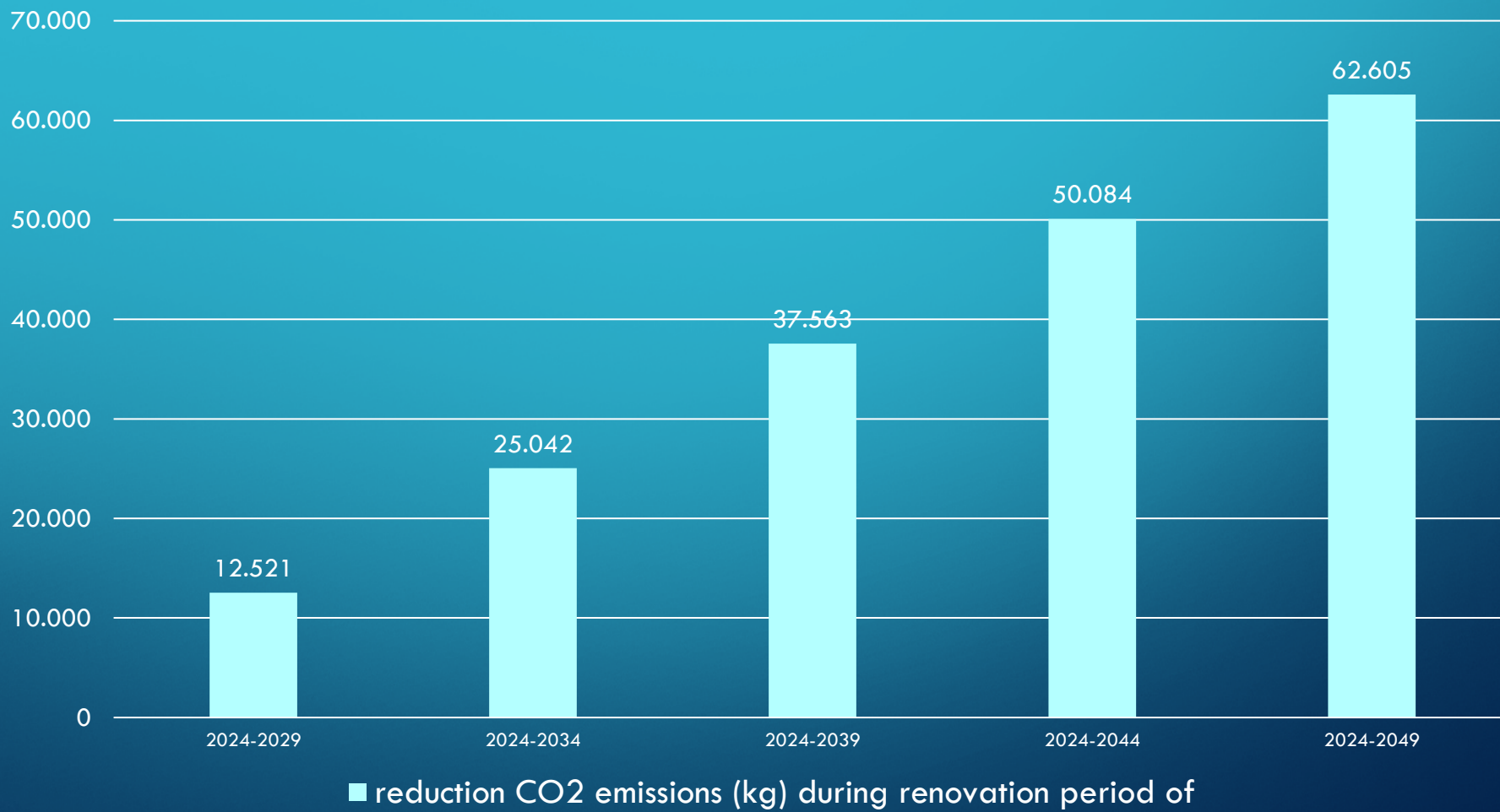
CLIMATE CHANGE – WHAT’S IN IT FOR CLIMATE?

Terraced house - CO2 reduction



CLIMATE CHANGE – WHAT’S IN IT FOR CLIMATE?

Terraced house - Trias Climatica CO2 reduction vs Trias Energetica

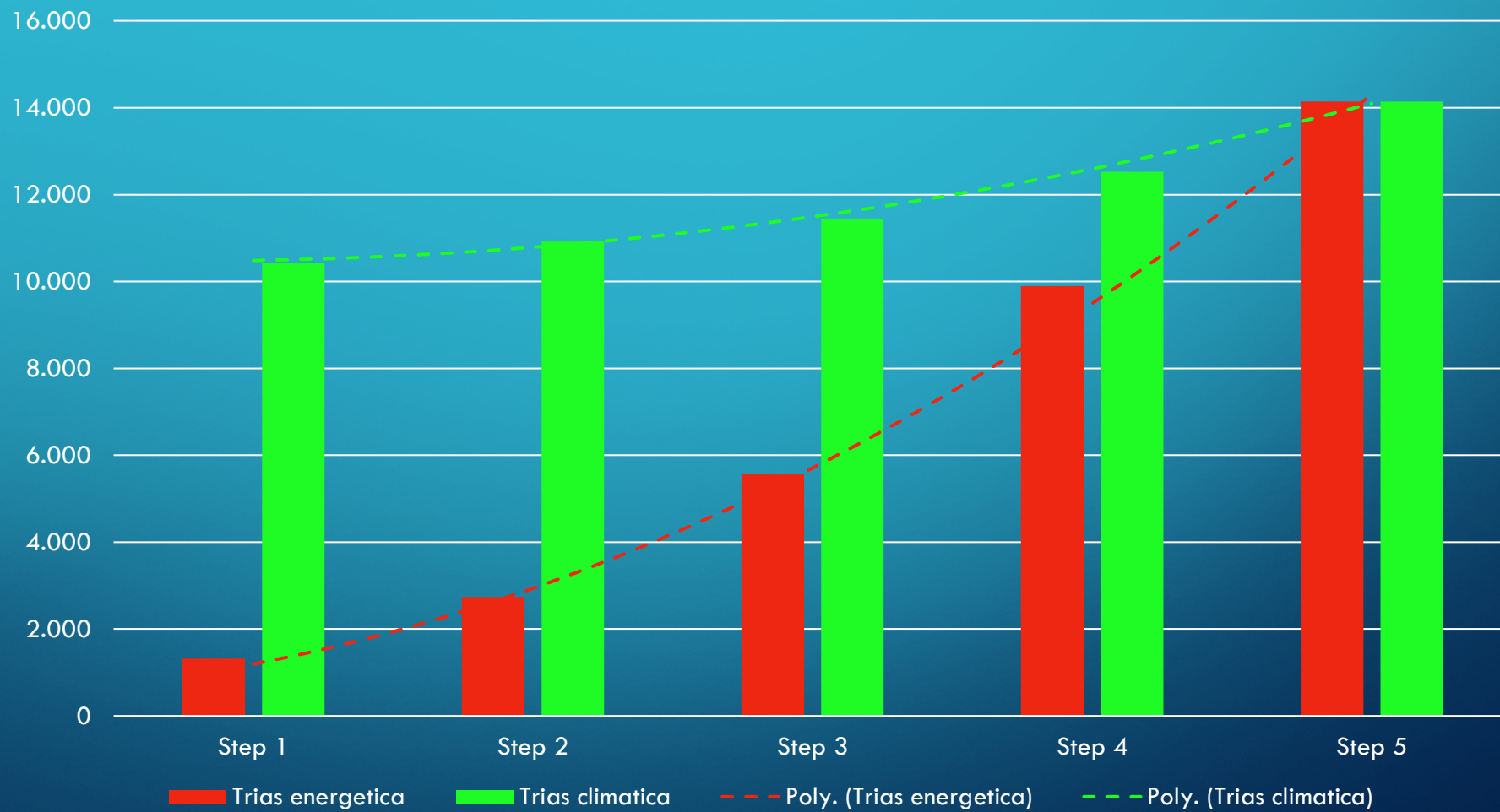


CLIMATE CHANGE – WHAT’S IN IT FOR CLIMATE?

	single house oil non-condensing	Trias Energetica		single house oil non-condensing	Trias Climatica	
		CO2 emissions	CO2 reduction		CO2 emissions	CO2 reduction
	Original situation	16.640		Original situation	16.640	
Renovation steps	Roofs	15.322	-1.318	Heating	6.211	-10.429
	Roofs+Walls	13.900	-1.422	Heating+Roofs	5.721	-490
	Roofs+Walls+Windows	11.077	-2.823	Heating+Roofs+Walls	5.190	-531
	Roofs+Walls+Windows+Floors	6.747	-4.330	Heating+Roofs+Walls+Windows	4.113	-1.077
	Roofs+Walls+Windows+Floors+Heating	2.496	-4.251	Heating+Roofs+Walls+Windows+Floors	2.496	-1.617

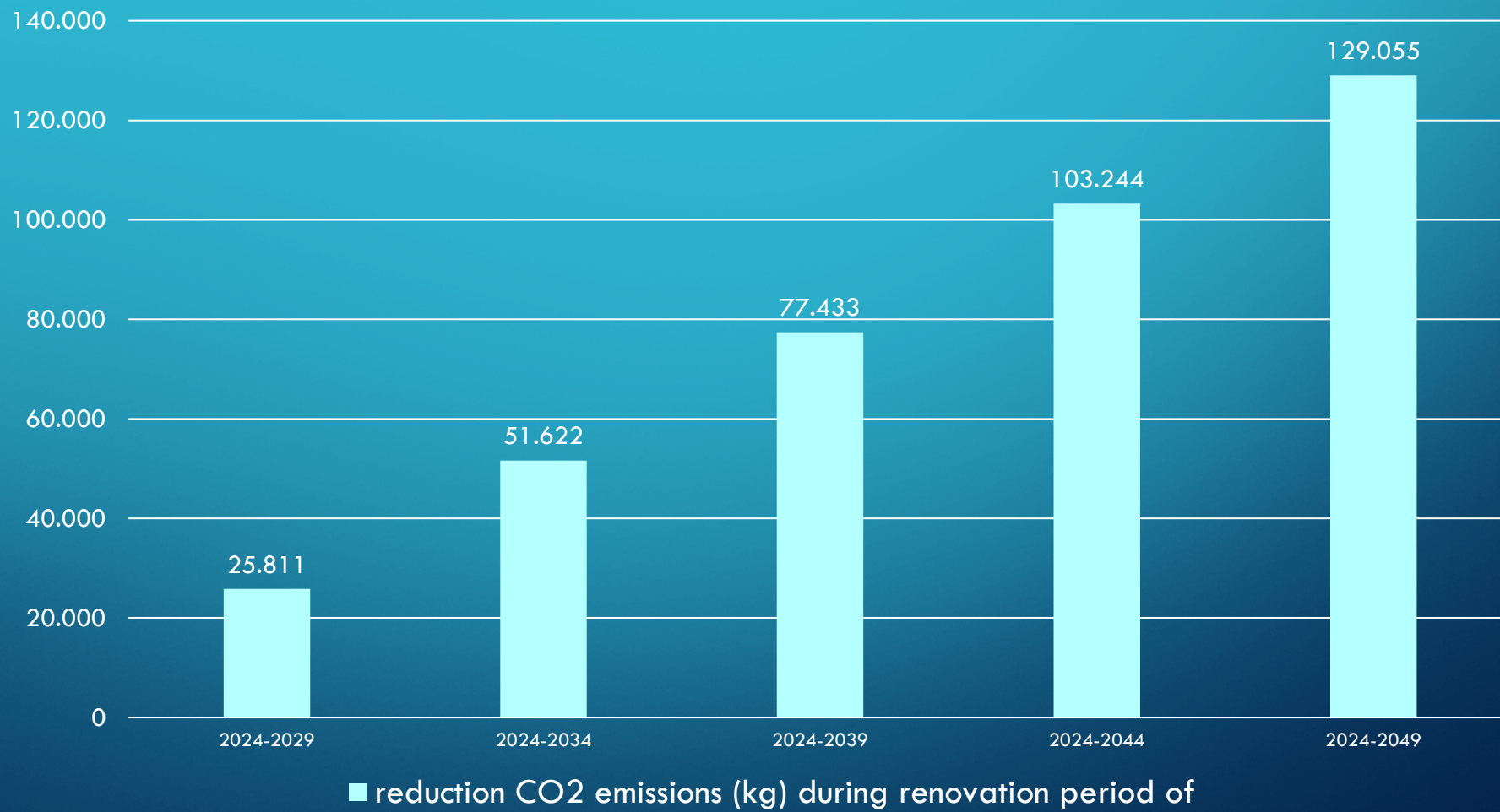
CLIMATE CHANGE – WHAT’S IN IT FOR CLIMATE?

Single house - CO2 reduction



CLIMATE CHANGE – WHAT’S IN IT FOR CLIMATE?

Single house - Trias Climatica CO2 reduction vs Trias Energetica



PROGRAMM

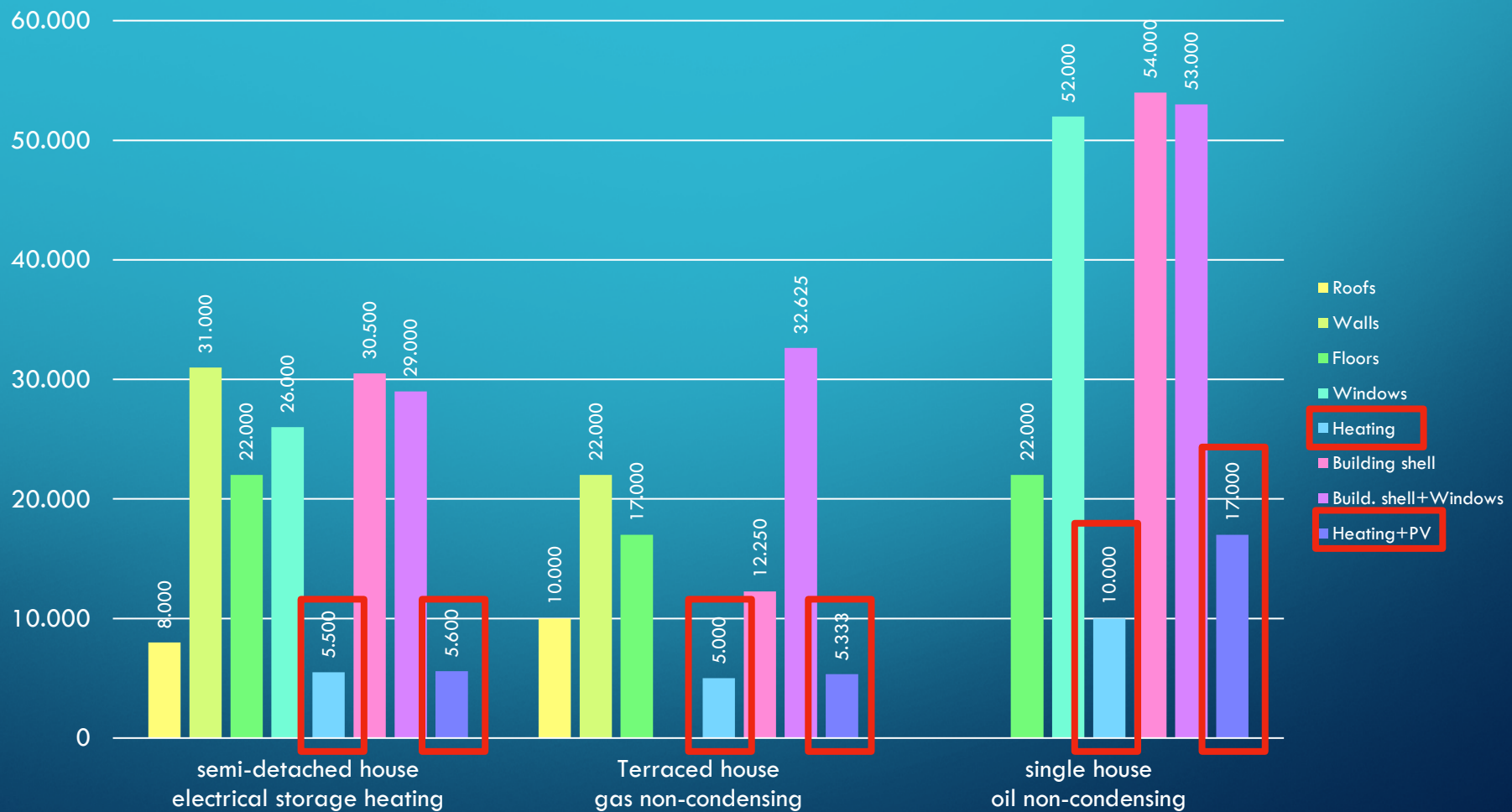
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CLIMATE CHANGE – WHAT’S IN IT FOR THE OWNER?

Renovation step	Labels	semi-detached house electrical storage heating		Terraced house gas non-condensing		single house oil non-condensing				
		Label increase	Investment €	Label increase	Investment €	Label increase	Investment €			
	Original situation	F		F		D				
Individual	Roofs	E	1	8.000 €	E	1	10.000 €	D	0	6.500 €
	Walls	E	1	31.000 €	E	1	22.000 €	D	0	25.500 €
	Floors	E	1	22.000 €	E	1	17.000 €	C	1	22.000 €
	Windows	E	1	26.000 €	F	0	81.500 €	C	1	52.000 €
	Heating	B	4	22.000 €	D	2	10.000 €	C	1	10.000 €
Combined	Building shell	D	2	61.000 €	B	4	49.000 €	C	1	54.000 €
	Build. shell+Windows	C	3	87.000 €	B	4	130.500 €	B	2	106.000 €
	Heating+PV	A	5	28.000 €	C	3	16.000 €	C	1	17.000 €

CLIMATE CHANGE – WHAT’S IN IT FOR THE OWNER?

Overview renovation steps – invested €/label jump



CLIMATE CHANGE – WHAT’S IN IT FOR THE OWNER?

Median building prices:

- Belgium:
 - terraced: 264.500 €
 - semi-detached: 264.500 €
 - single house: 370.000 €

• Wallonia

- terraced: 264.500 €

• Flanders:

- terraced: 300.000 €
- semi-detached: 300.000 €
- single house: 410.000 €

Investment (heating hybridisation) to increase label level (one level):

- terraced: 5.000 €
- semi-detached: 5.500 €
- single house: 10.000 €

- terraced: 5.000 € 2,8%
- semi-detached: 5.500 € 3,0%
- single house: 10.000 € 3,4%

• Flanders:

- terraced: 5.000 € 1,7%
- semi-detached: 5.500 € 1,8%
- single house: 10.000 € 2,4%

The impact on the building value is bigger than the investment
ROI < 1 year

Source: <https://statbel.fgov.be/nl/themas/bouwen-wonen/vastgoedprijzen>

CLIMATE CHANGE – WHAT’S IN IT FOR THE OWNER?

Label increase depends on the applied scale of labels

Renovation action	Regional labels comparison	semi-detached house electrical storage heating			Terraced house gas non-condensing			single house oil non-condensing					
		EPC value Flanders	Label Flanders	Label Brussels	Label Wallonia	EPC value Flanders	Label Flanders	Label Brussels	Label Wallonia	EPC value Flanders	Label Flanders	Label Brussels	Label Wallonia
	Actual	541	F	G	G	620	F	G	G	365	D	G	E
Individual	Roofs	481	E	G	F	403	E	G	E	336	D	F	D
	Walls	433	E	G	F	476	E	G	F	332	D	F	D
	Floors	489	E	G	F	540	F	G	G	269	C	E	D
	Windows	477	E	G	F	584	F	G	G	285	C	F	D
	Heating	151	B	D	B	351	D	G	E	248	C	E	C
Combined	Building shell	323	D	F	D	182	B	D	C	211	C	E	C
	Build. shell+Windows	249	C	E	C	142	B	C	B	135	B	C	B
	Heating+PV	55	A	B	A	291	C	F	D	204	C	D	C

But heating hybridisation remains the main driver to perform significantly better at lowest CAPEX

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CLIMATE CHANGE – CAN WE?

Segment	2020	2021	2022
Heat generators	210.000	240.000	230.000
Airconditioning	150.000	160.000	150.000
Potential heating installers	85.000	95.000	95.000
Potential cooling installers	95.000	105.000	100.000
Total potential HP installations/y	180.000	200.000	195.000
<u># buildings in BE</u>	5.576.120	5.627.641	5.680.956
# central heating (85%)	4.739.702	4.783.495	4.828.813
Renovation ratio	3,8%	4,3%	4,1%

Yes we can!

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CLIMATE CHANGE – TRIAS CLIMATICA ADVANTAGES

2030 climate and energy framework - key targets

- ✓ • Greenhouse gas emissions: from 40% to at least 55% reduction (compared to 1990 levels)
- ✓ • Renewable energy: from 32% to 42.5% share
- ✓ • Energy efficiency target for final energy consumption: from 32.5% to 36%
- ✓ • Energy efficiency target for primary energy consumption: 39%

Source: https://climate.ec.europa.eu/eu-action/climate-strategies-targets/2030-climate-energy-framework_en#greenhouse-gas-emissions---raising-the-ambition

CLIMATE CHANGE – TRIAS CLIMATICA ADVANTAGES

The national plans outline how the EU countries intend to address the 5 dimensions of the energy union:

- ✓ • decarbonisation
- ✓ • energy efficiency
- ✓ • energy security
- ✓ • internal energy market
- ✓ • research, innovation and competitiveness

Source: https://commission.europa.eu/energy-climate-change-environment/implementation-eu-countries/energy-and-climate-governance-and-reporting/national-energy-and-climate-plans_en

TRIAS CLIMATICA

ACCELERATING CLIMATE TRANSITION IN EXISTING BUILDING STOCK

- Faster reduction of CO₂-emissions and thus faster reaching the EU targets
 - Fit for 55 (2030)
 - Carbon neutral (2050)
- Lowest investment for a faster climate change
 - ROI for the owner < 1 year due to better value for his property (better energy label)
 - Lowest investment cost per saved kg CO₂-emission
- Heating and cooling sector have together today a potential renovation rate > 3%

PROGRAMM

1. Easy tools to understand climate change
2. EU goals and time lines
3. EU goals and focus
4. How do we plan to do it?
5. Speeding-up Climate change needs a Mind change
6. How to speed-up?
7. Focus on the heat generator
8. What's in it for climate?
9. What's in it for the owner?
10. Yes we can!
11. Trias Climatica advantages





TRIAS CLIMATICA

ACCELERATING CLIMATE TRANSITION IN EXISTING BUILDING STOCK

THANKS FOR ATTENDING AND SPREAD THE WORD!



Ivan Piette

Energy consulting & expertise

energy@optimized.be

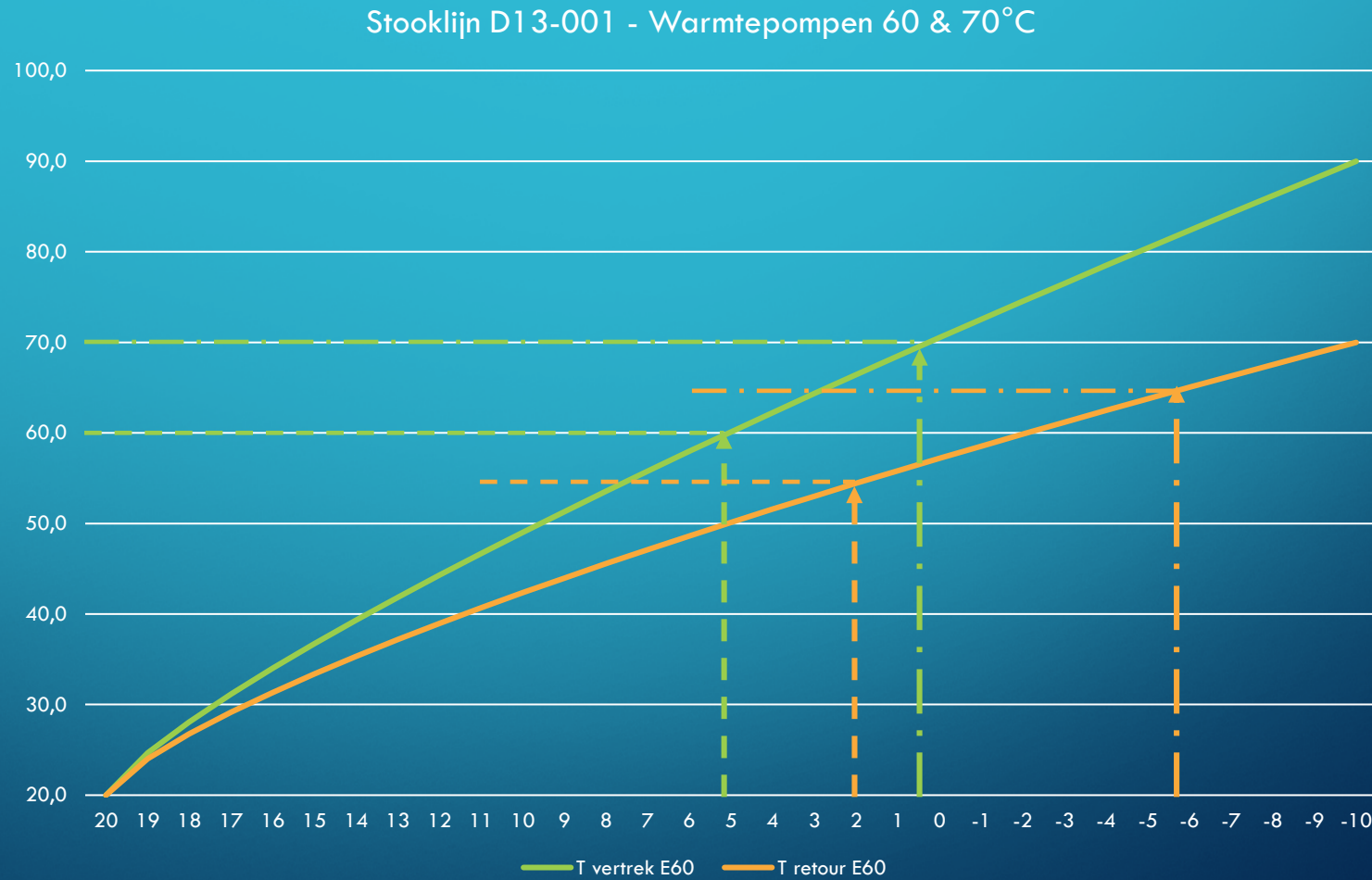
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USEFULL LINKS

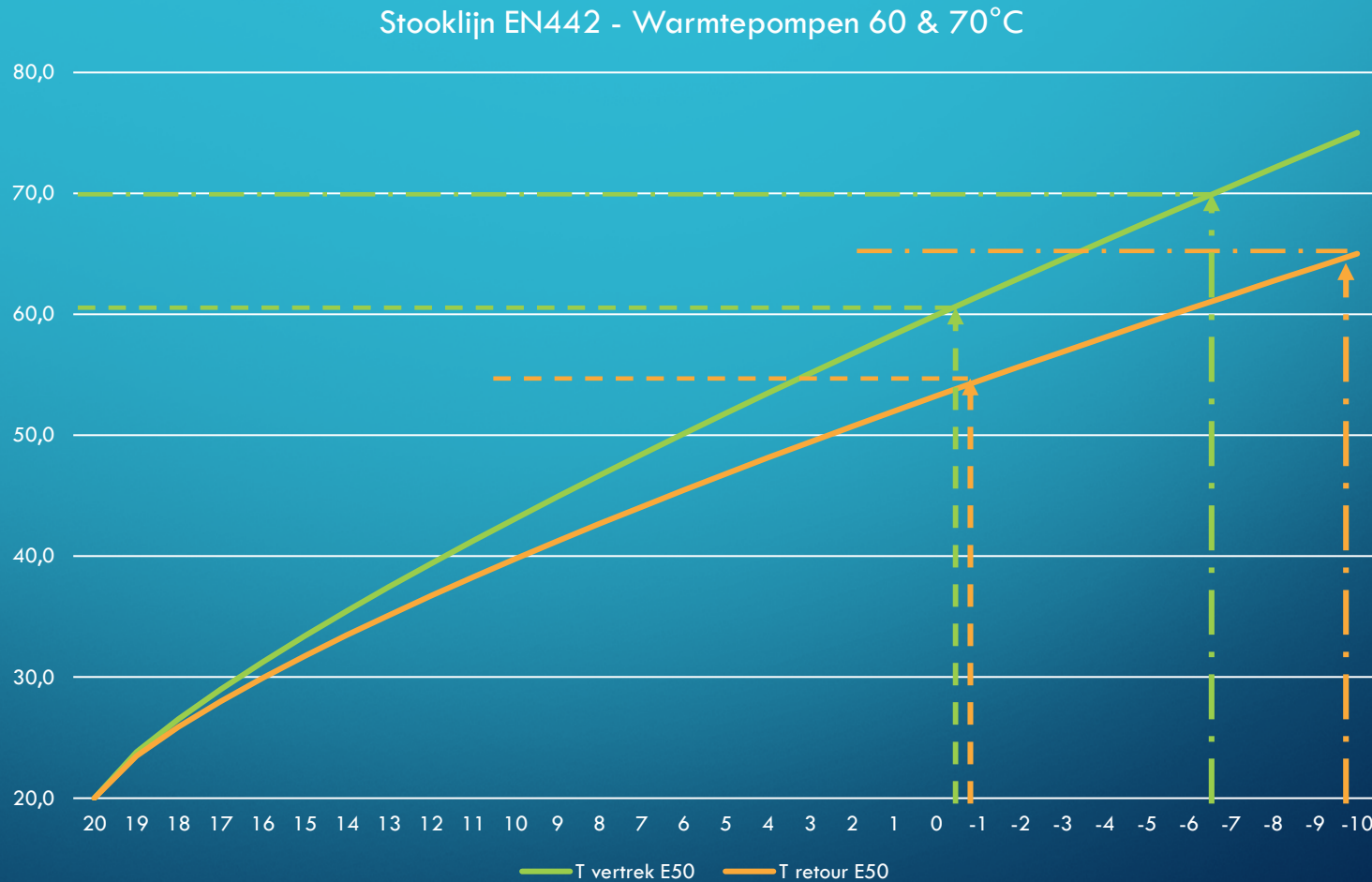
- European Commission, Directorate-General for Climate Action, *Going climate-neutral by 2050 – A strategic long-term vision for a prosperous, modern, competitive and climate-neutral EU economy*, Publications Office, 2019, <https://data.europa.eu/doi/10.2834/02074>
- https://climate.ec.europa.eu/eu-action/climate-strategies-targets/2050-long-term-strategy_nl
- <https://open.overheid.nl/documenten/ronl-archieff-14a8040f-1bbf-4a6a-b6dd-d0ad90cd9ecd/pdf>
- <https://www.tweedekamer.nl/downloads/document?id=2021D15673>
- <https://www.nlingenieurs.nl/assets/Documenten/Position-paper-Energietransitie-Koninklijke-NLingenieurs.pdf>
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- https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/delivering-european-green-deal_en
- <https://www.ipcc.ch/sr15/>
- https://nieuws.pixii.be/nieuws/eerst-de-bouwschil-bij-renovaties/?mc_cid=49fb10b6e9&mc_eid=54c435cf9c
- <https://journal-buildingscities.org/articles/10.5334/bc.388?ref=nieuws.pixii.be>

Back-up

STOOKLIJN NBN D13-001 - WARMTEPOMPEN 60 & 70°C



STOOKLIJN NBN EN 442 - WARMTEPOMPEN 60 & 70°C



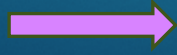
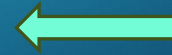
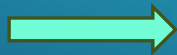
STOOKLIJN NBN EN 442 – VERTREK- EN RETOURTEMPERATUREN

Radiatoren vanaf 1996 - NBN EN 442 - E50				n=	1,3
		ΔT_m	49,83		
Buitentemperatuur	Warmteverlies	$\Delta T_{CV E50}$	$\Delta T_{m, season E50}$	T vertrek E50	T retour E50
20	0,0%	0,0	0,00	20,0	20,0
19	3,3%	0,3	3,64	23,8	23,5
18	6,7%	0,7	6,21	26,5	25,9
17	10,0%	1,0	8,48	29,0	28,0
16	13,3%	1,3	10,58	31,3	29,9
15	16,7%	1,7	12,56	33,4	31,7
14	20,0%	2,0	14,45	35,5	33,5
13	23,3%	2,3	16,27	37,5	35,1
12	26,7%	2,7	18,03	39,4	36,7
11	30,0%	3,0	19,74	41,3	38,3
10	33,3%	3,3	21,40	43,1	39,8
9	36,7%	3,7	23,03	44,9	41,2
8	40,0%	4,0	24,63	46,7	42,7
7	43,3%	4,3	26,19	48,4	44,1
6	46,7%	4,7	27,73	50,1	45,5
5	50,0%	5,0	29,24	51,8	46,8
4	53,3%	5,3	30,73	53,5	48,1
3	56,7%	5,7	32,19	55,1	49,4
2	60,0%	6,0	33,64	56,7	50,7
1	63,3%	6,3	35,07	58,3	52,0
0	66,7%	6,7	36,48	59,9	53,2
-1	70,0%	7,0	37,88	61,5	54,5
-2	73,3%	7,3	39,26	63,0	55,7
-3	76,7%	7,7	40,62	64,6	56,9
-4	80,0%	8,0	41,97	66,1	58,1
-5	83,3%	8,3	43,31	67,6	59,3
-6	86,7%	8,7	44,64	69,1	60,4
-7	90,0%	9,0	45,95	70,6	61,6
-8	93,3%	9,3	47,26	72,1	62,7
-9	96,7%	9,7	48,55	73,5	63,9
-10	100,0%	10,0	49,83	75,0	65,0

Radiatoren 75/65:

Max 60°C

Max 70°C



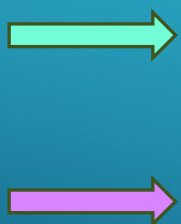
STOOKLIJN NBN D 13-001 – VERTREK- EN RETOURTEMPERATUREN

Radiatoren voor 1996 - NBN D13-001 - E60				n=	1,3
			ΔT_m	59,44	
Buitentemperatuur	Warmteverlies	$\Delta T_{CV E60}$	$\Delta T_{m, season E60}$	T vertrek E60	T retour E60
20	0,0%	0,0	0,00	20,0	20,0
19	3,3%	0,7	4,34	24,7	24,0
18	6,7%	1,3	7,40	28,1	26,8
17	10,0%	2,0	10,11	31,1	29,1
16	13,3%	2,7	12,62	34,0	31,3
15	16,7%	3,3	14,98	36,7	33,4
14	20,0%	4,0	17,24	39,3	35,3
13	23,3%	4,7	19,40	41,8	37,2
12	26,7%	5,3	21,50	44,3	38,9
11	30,0%	6,0	23,54	46,7	40,7
10	33,3%	6,7	25,53	49,0	42,3
9	36,7%	7,3	27,47	51,3	44,0
8	40,0%	8,0	29,37	53,6	45,6
7	43,3%	8,7	31,24	55,8	47,1
6	46,7%	9,3	33,07	58,0	48,6
5	50,0%	10,0	34,88	60,1	50,1
4	53,3%	10,7	36,65	62,2	51,6
3	56,7%	11,3	38,40	64,3	53,0
2	60,0%	12,0	40,13	66,4	54,4
1	63,3%	12,7	41,83	68,5	55,8
0	66,7%	13,3	43,51	70,5	57,2
-1	70,0%	14,0	45,18	72,5	58,5
-2	73,3%	14,7	46,82	74,5	59,9
-3	76,7%	15,3	48,45	76,5	61,2
-4	80,0%	16,0	50,07	78,5	62,5
-5	83,3%	16,7	51,66	80,4	63,8
-6	86,7%	17,3	53,24	82,4	65,0
-7	90,0%	18,0	54,81	84,3	66,3
-8	93,3%	18,7	56,37	86,2	67,5
-9	96,7%	19,3	57,91	88,1	68,8
-10	100,0%	20,0	59,44	90,0	70,0

Radiatoren 90/70:

Max 60°C

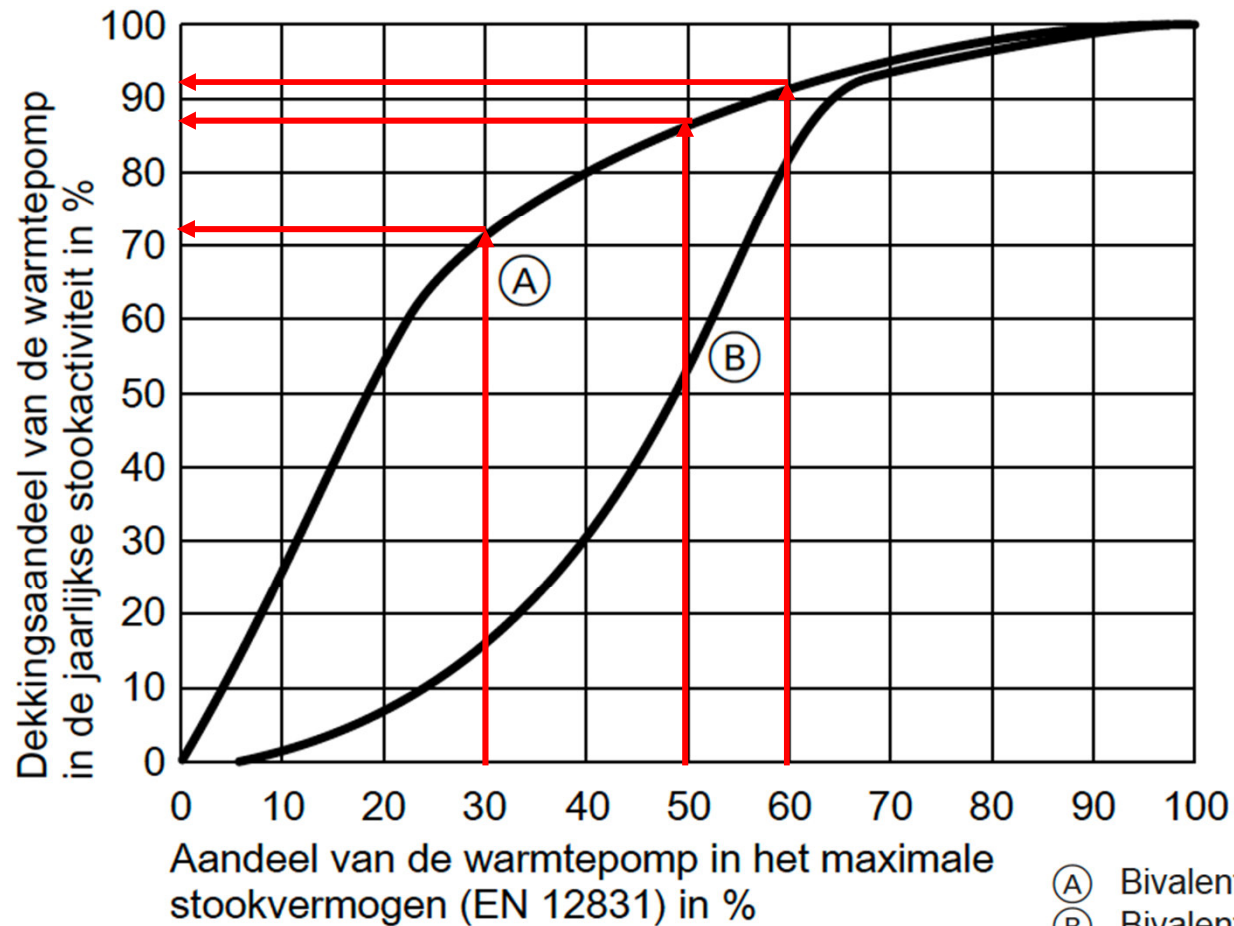
Max 70°C



WARMTEPOMP - BIVALENTIEPUNT

Hybridisatie
van de
installaties

Dekkingspercentages van bivalente werking



- (A) Bivalent-parallele werkingwijze
- (B) Bivalent-alternatieve werkingwijze

IMPACT E-PEIL OP WAARDE WONINGEN

Gevolg is dat de huizen met EPC-score E of F in het laatste kwartaal van vorig jaar 3,7 procent aan waarde verloren in vergelijking met het laatste kwartaal 2022. Maar bij de energiezuinige woningen met een EPC-score van A of B zien we een andere beweging: zij werden 1,5 procent duurder. Dat is de werkelijkheid achter het

OPEX AND INTERNATIONAL ENERGY PRICES

