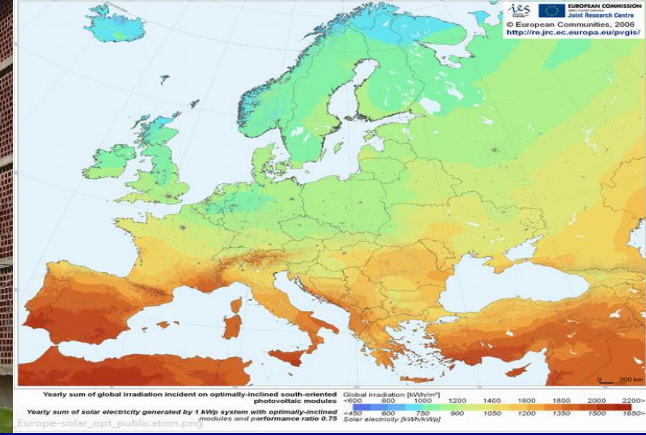




Challenges for carbon neutral social housing

A Portuguese Perspective

Vasco Peixoto de Freitas

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Faculty of Engineering - Porto University

Social Green - Conference 26 march 2019

CASA DA MÚSICA - PORTO - PORTUGAL

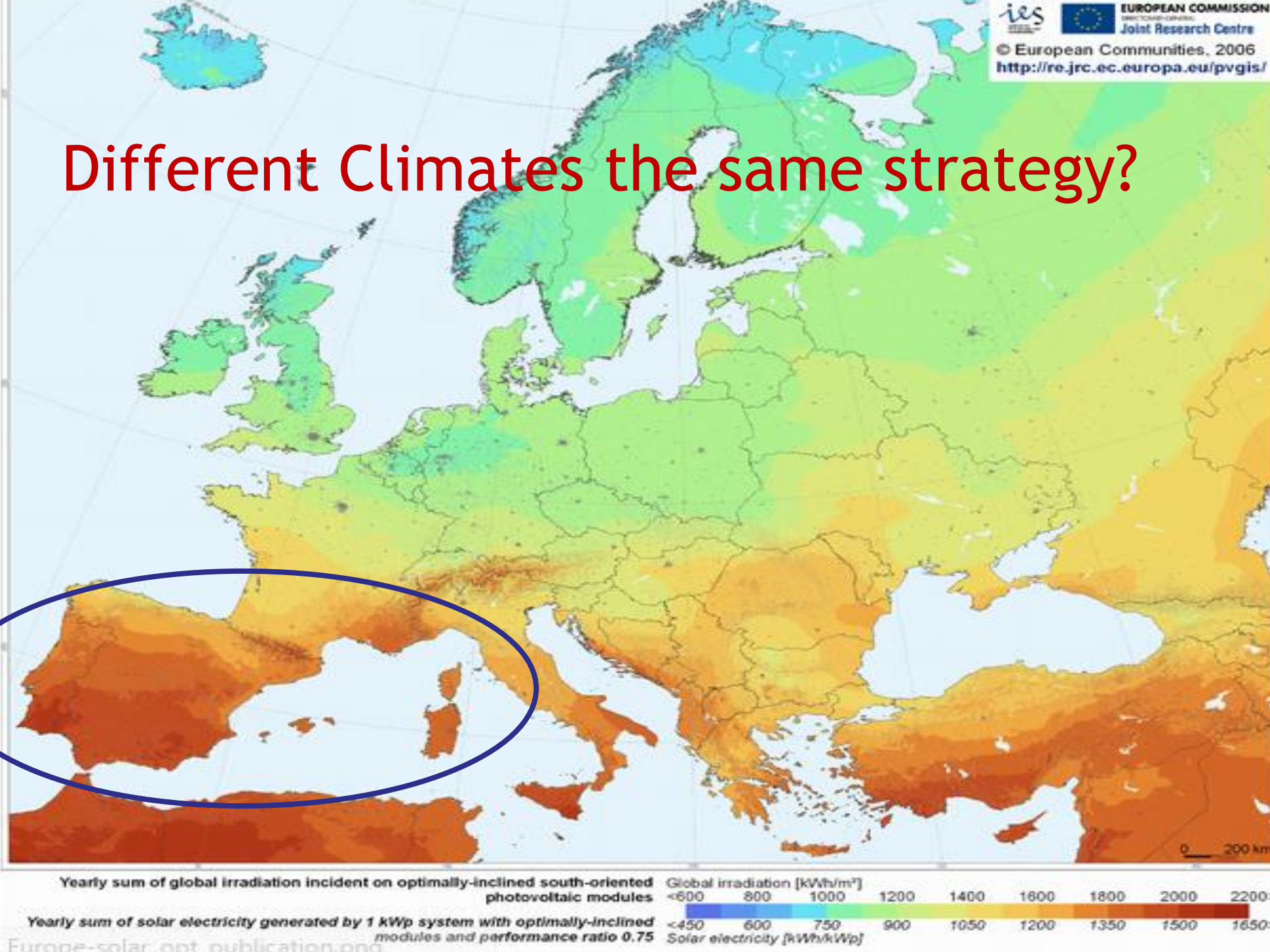
Content

1. Energy consumption vs comfort in social housing
2. Climate, Energy poverty and Cultural aspects
3. Discomfort and health in social housing
4. New Buildings
5. Building Rehabilitation
6. Proposed methodology- Passive discomfort index
7. Conclusion

1

Energy consumption vs comfort in social housing

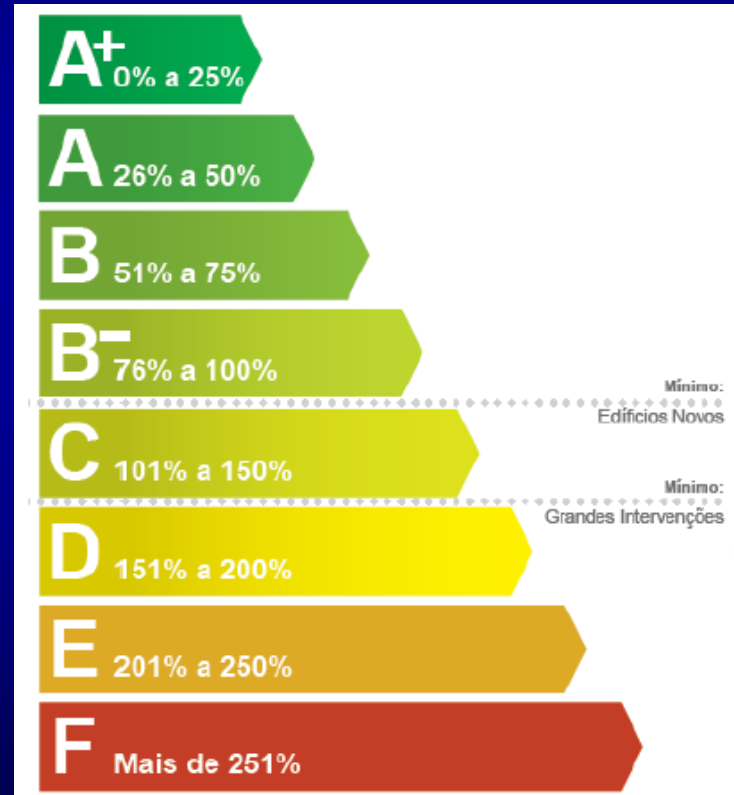
Different Climates the same strategy?



Energy performance label

$$R_{Nt} = \frac{N_{tc}}{N_t}$$

	Classe Energé	Valor de R_{Nt}
Major Renovation New Buildings	A+	$R_{Nt} \leq 0,25$
	A	$0,26 < R_{Nt} \leq 0,50$
	B	$0,51 < R_{Nt} \leq 0,75$
	B-	$0,76 < R_{Nt} \leq 1,00$
Existing Buildings	C	$1,01 < R_{Nt} \leq 1,50$
	D	$1,51 < R_{Nt} \leq 2,00$
	E	$2,01 < R_{Nt} \leq 2,50$
	F	$R_{Nt} \geq 2,51$

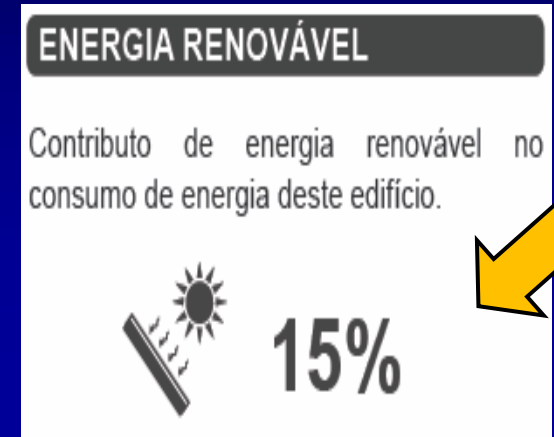


Model information

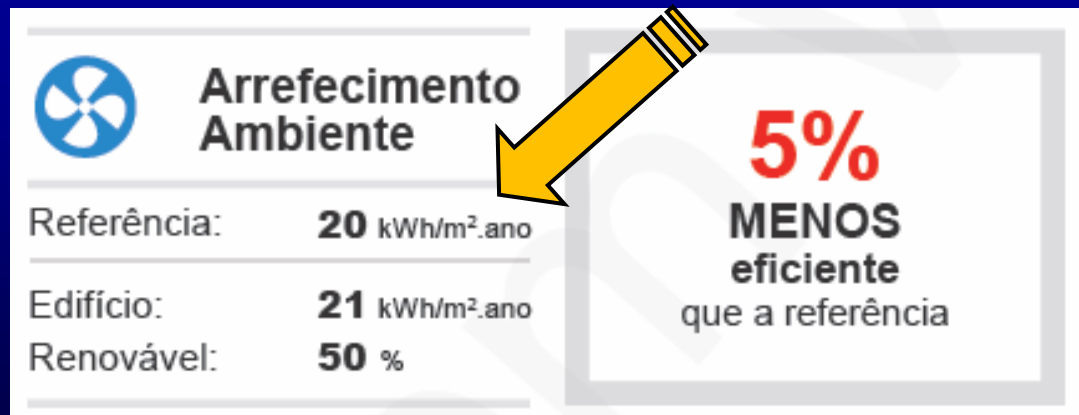
Heating



Renewal energy



Cooling



CO2 emission



In service conditions vs Certification

What is the difference
between the reference
consumption and the reality?

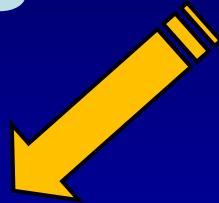
Does energy certification translate energy consumption and CO2 production?

No...
Why?

Reality - Social housing

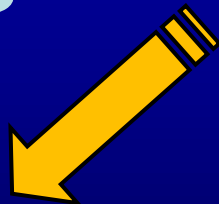
Heating

0 €



Cooling

0 €



Renewal energy

ENERGIA RENOVÁVEL

Contributo de energia renovável no consumo de energia deste edifício.



15%



CO2 emission

EMISSÕES DE CO₂

Emissões de CO₂ estimadas devido ao consumo de energia.



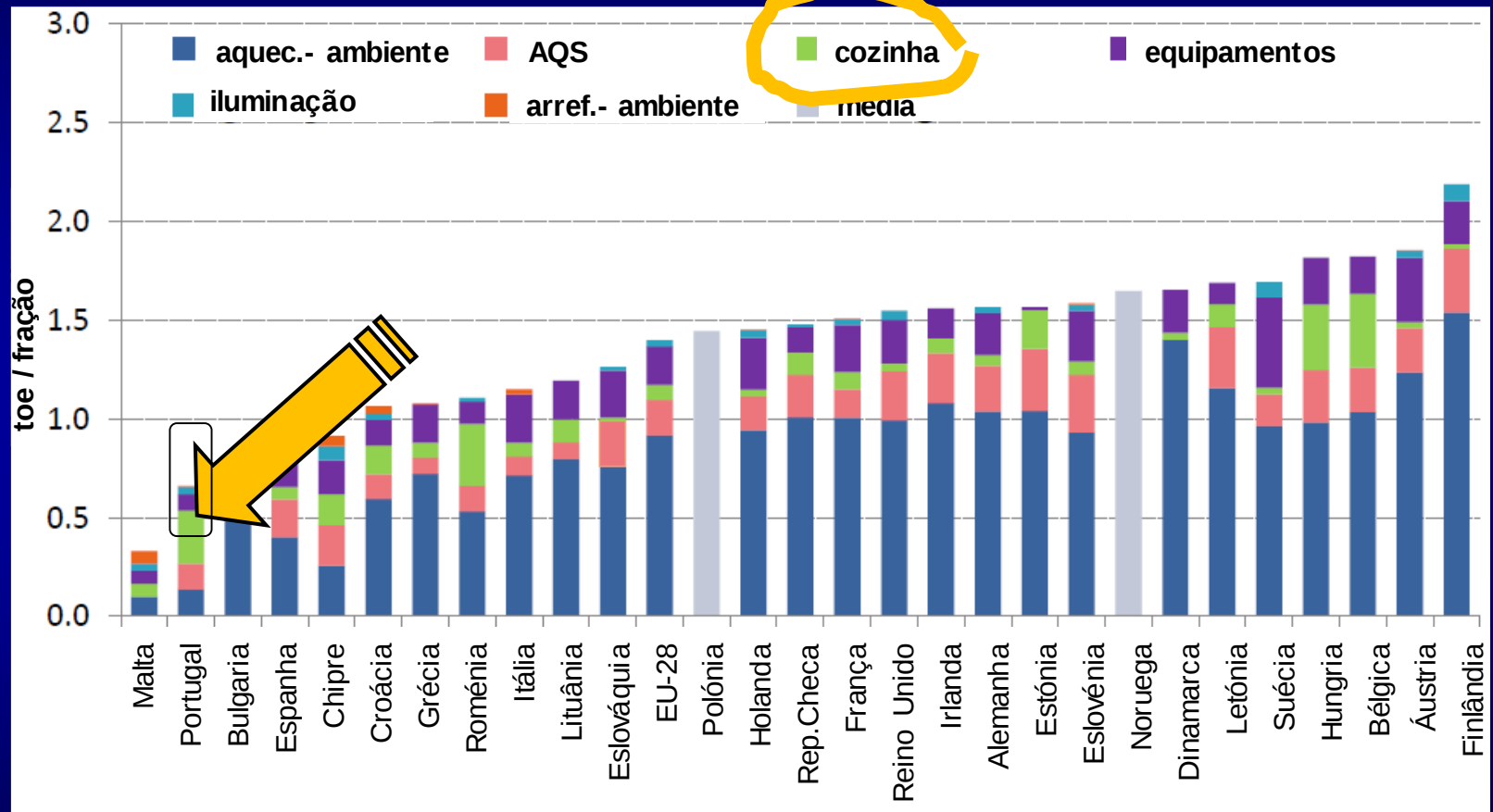
0,8

toneladas/ano



PORTUGAL

Energy consumption in the domestic sector in the EU (2012)

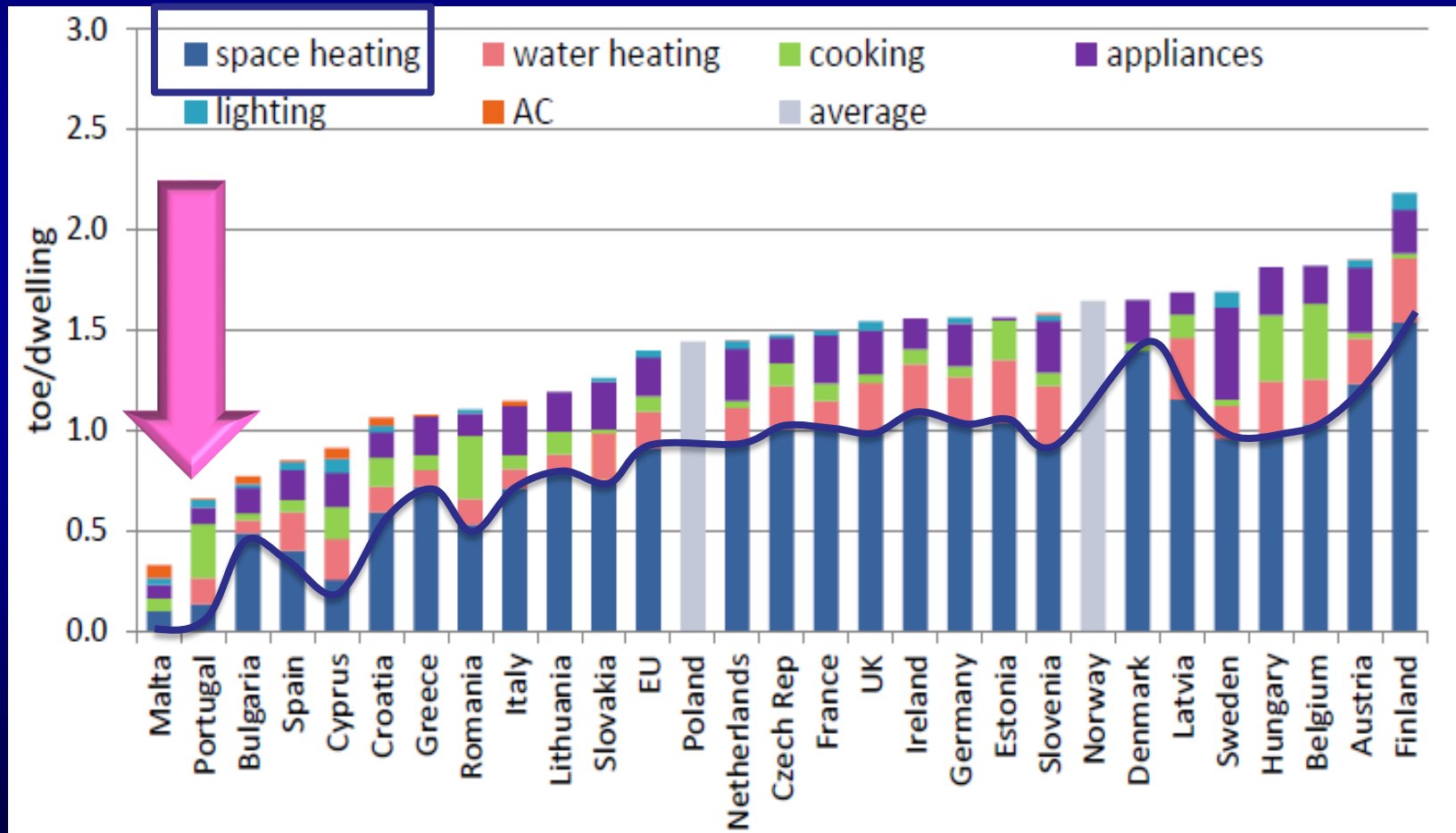


% heating in domestic consumption

EU - 67%
PT - 21%

Energy consumptions - Portugal vs. Europe

Low “Space heating” ...



(Lapillonne et al, 2015)

Sílvia A. Magalhães - Vasco Peixoto de Freitas

PORTUGAL

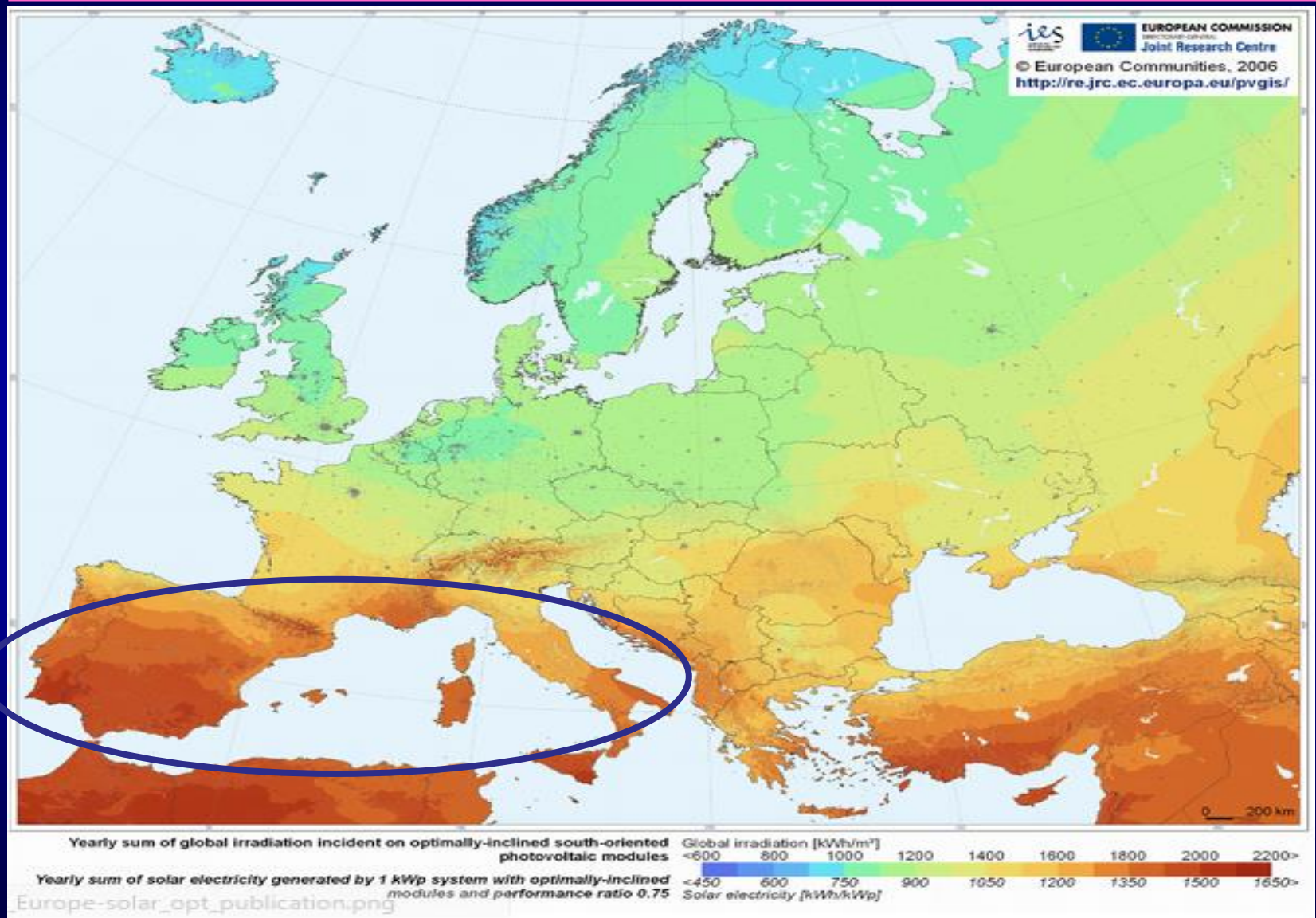


Why?

2

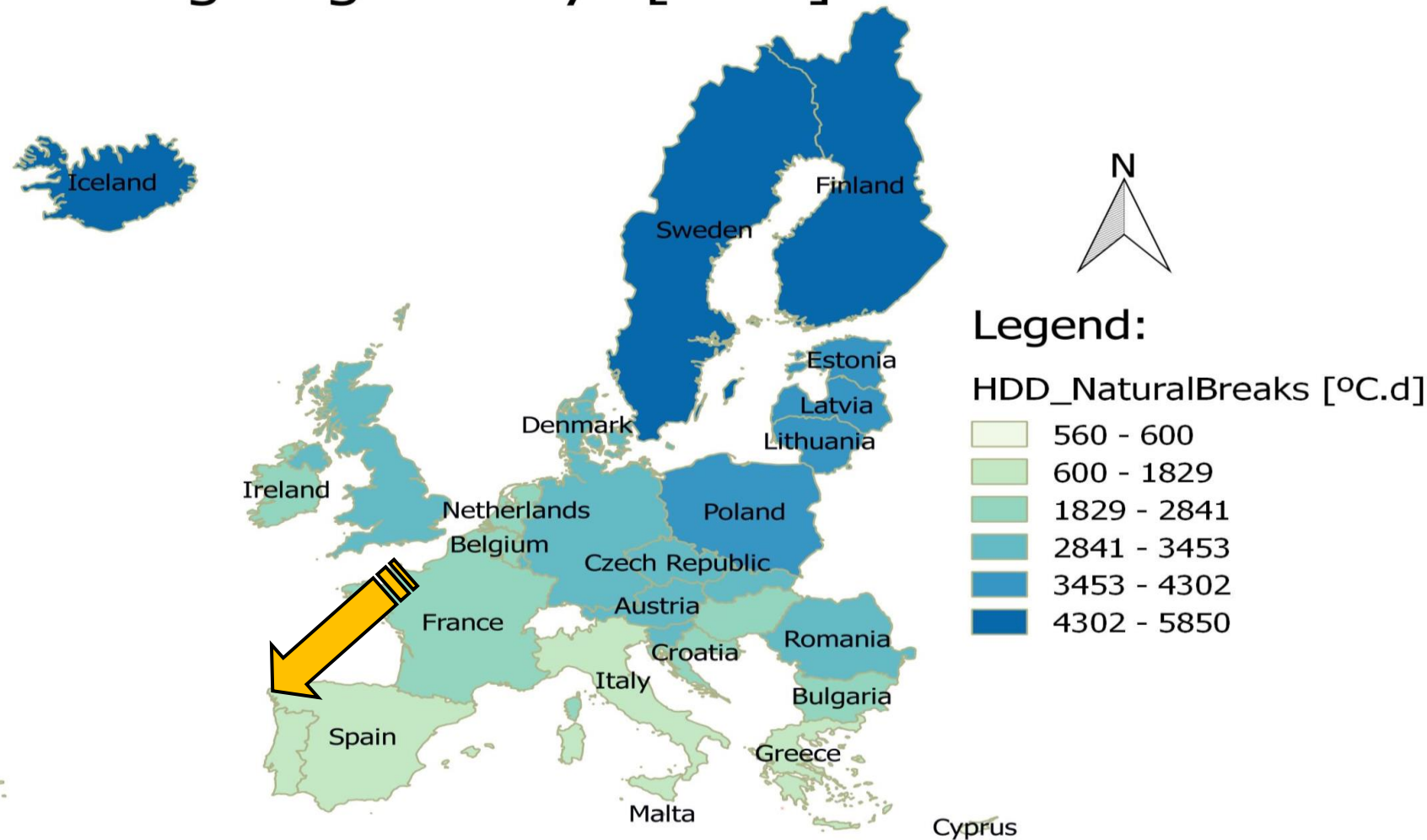
Climate, Energy poverty and Cultural aspects

Climate and Heating needs



Climate...

Heating Degree Days [HDD]

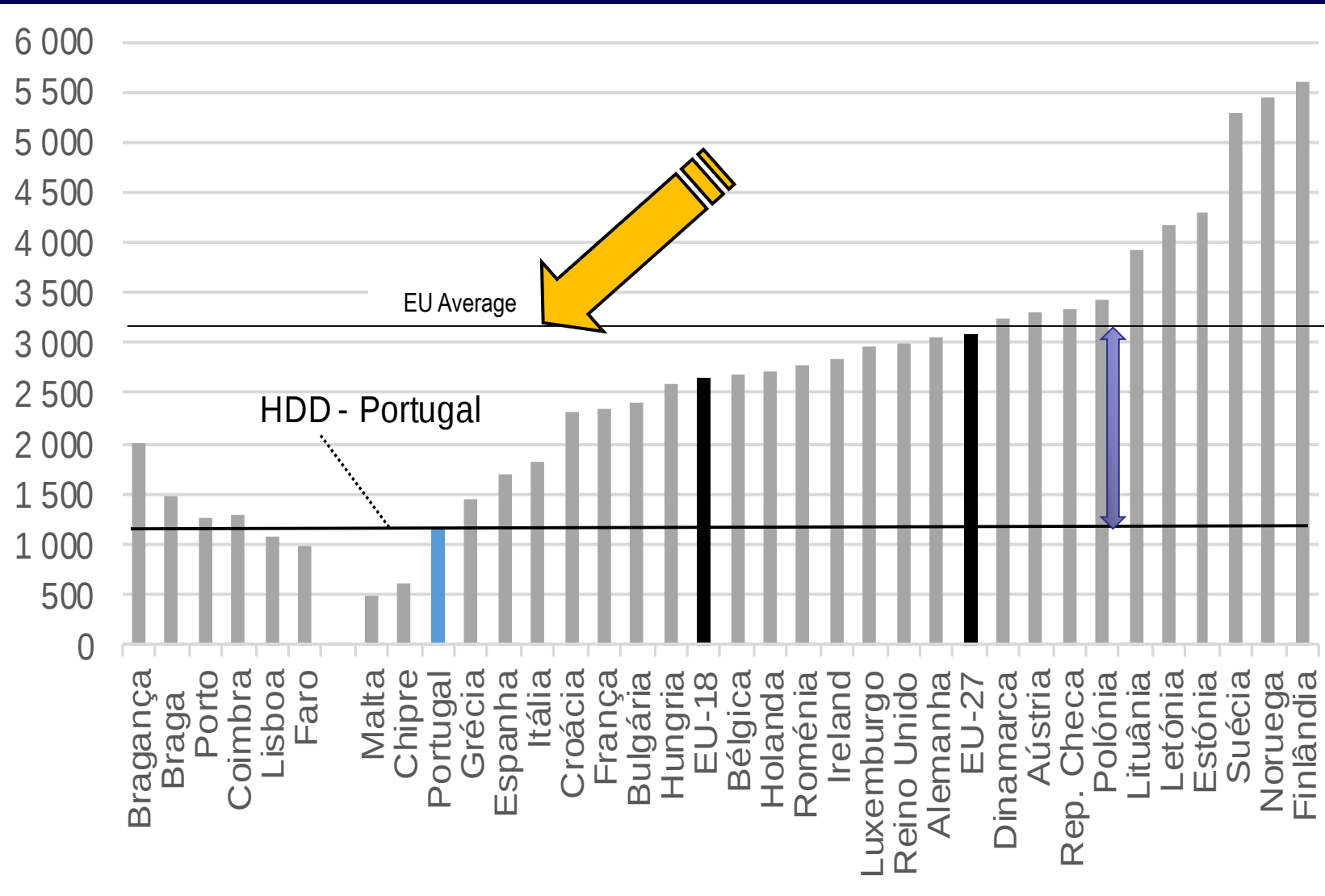


Fonte: Sílvia Magalhães (2017)

Vasco Peixoto de Freitas

2019 - 15

HDD



Heating degree days - north of Portugal

	GDA REF	$\Theta_{\text{ext},i}$ REF
	°C	°C
Minho-Lima	1629	2,2
Alto Trás-os-Montes	2015	5,5
Cávado	1491	9,0
Ave	1653	8,5
Grande Porto	1250	9,9
Tâmega	1570	7,8
Douro	1764	6,3
Entre Douro e Vouga	1544	8,4



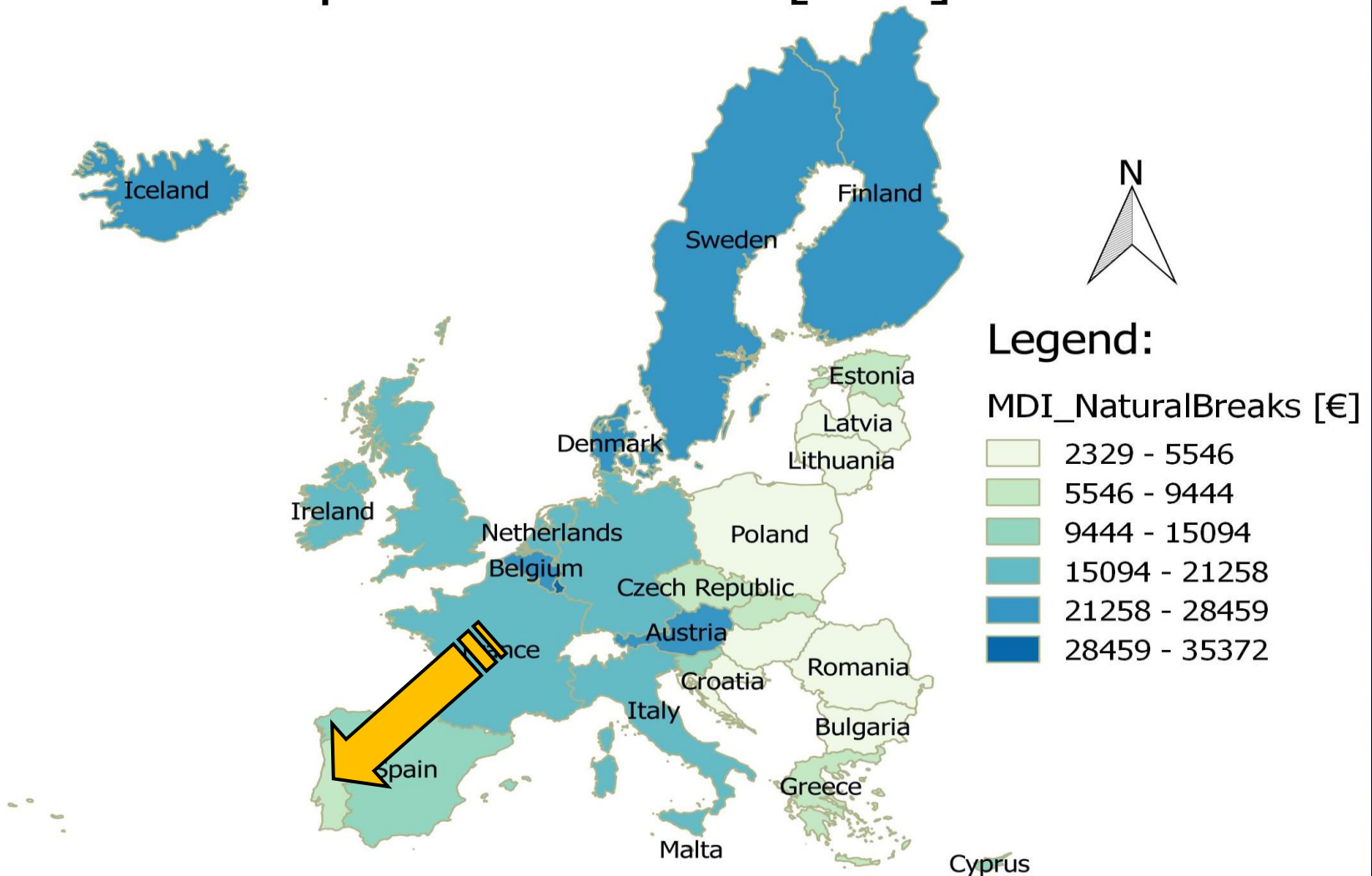
Source: RCCTE, Despacho (extrato) n.º 15793-F/2013 - Tabela 04

Portuguese average = 1165 HDD
European average = 3076 HDD

Source: Eurostat 2009

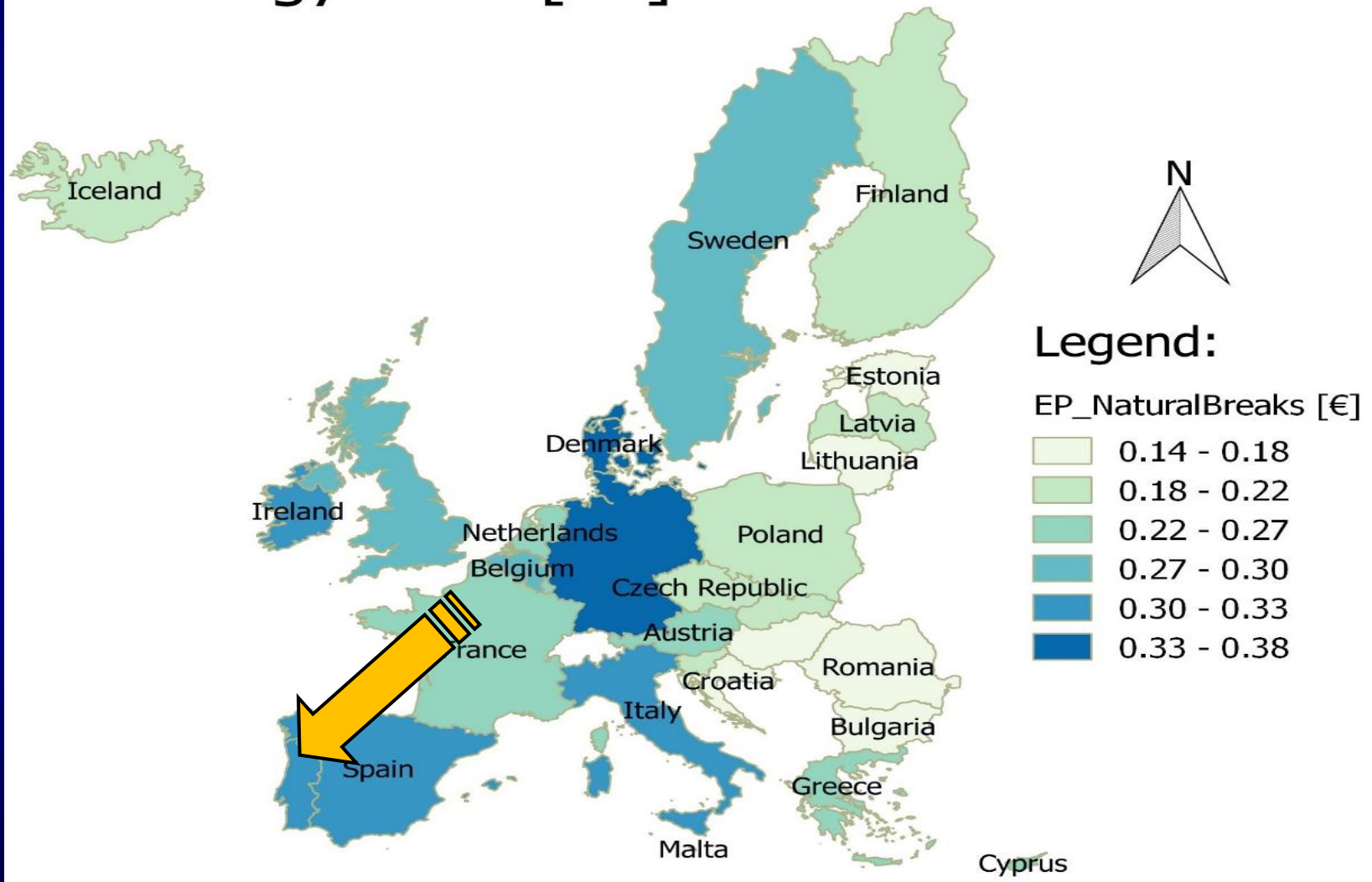
Income...

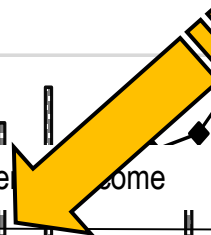
Median Disposable Income [MDI]



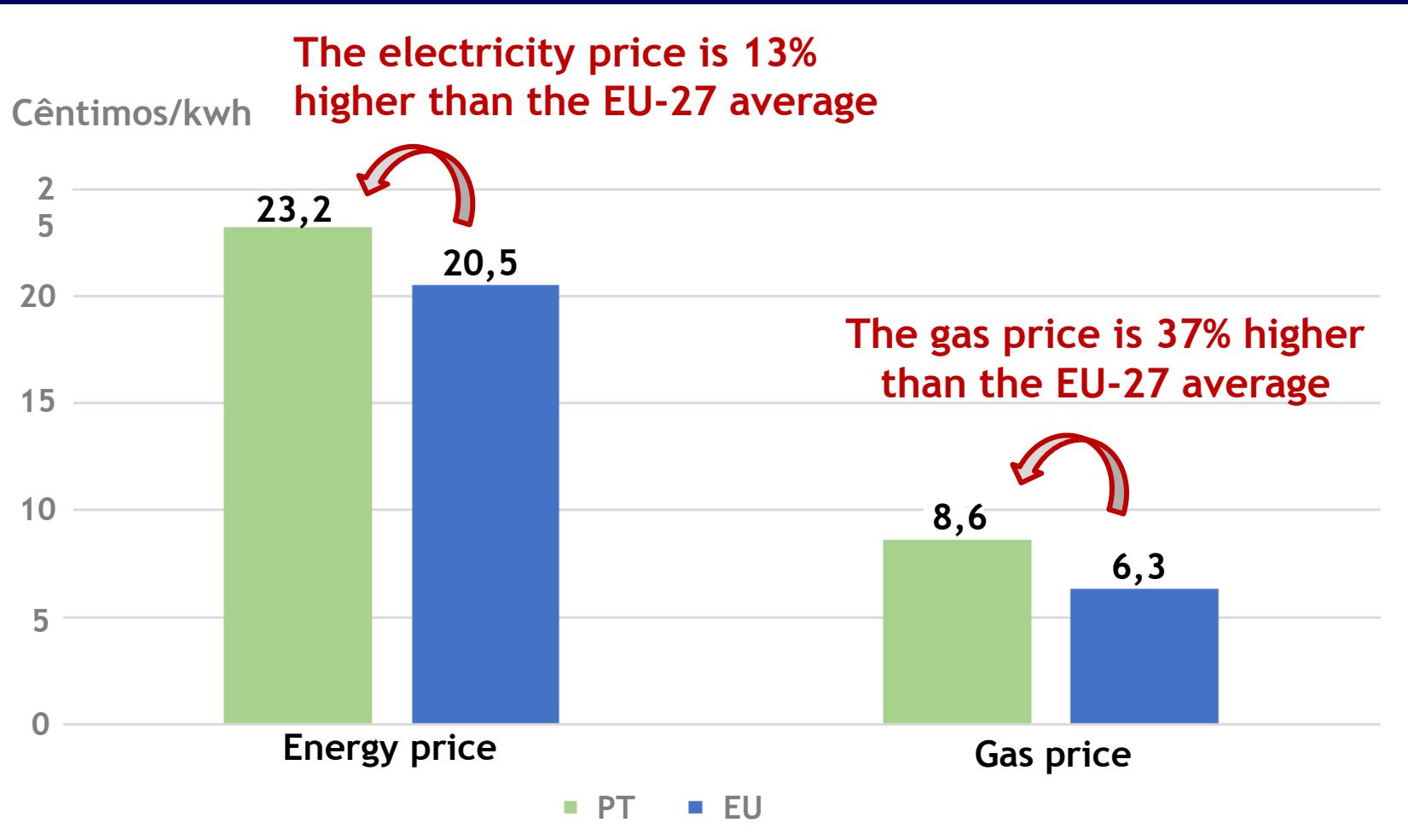
Energy price...

Energy Price [EP]





Electricity and gas average price - Portugal vs. EU (2016)



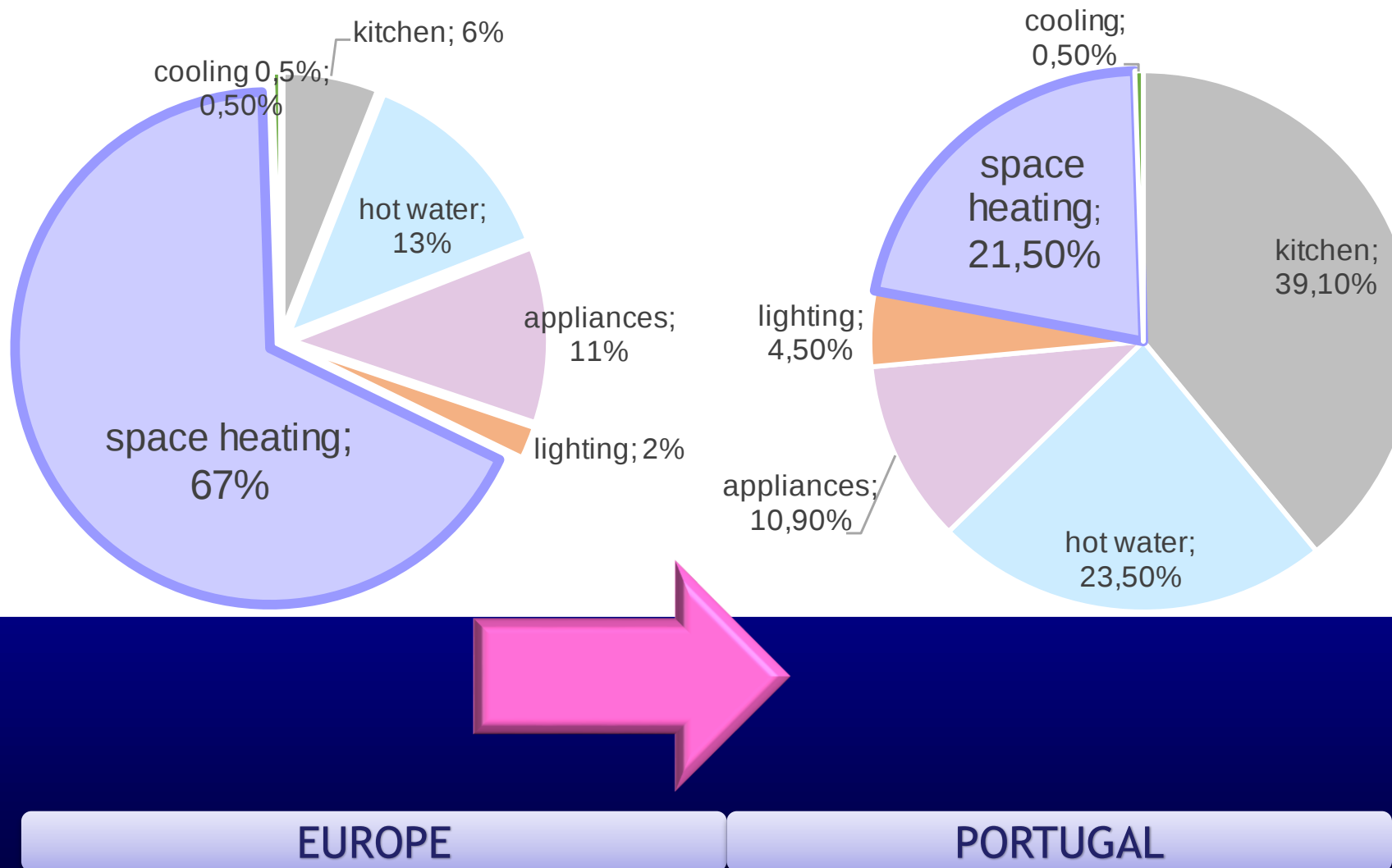
Source: <https://www.energypoverty.eu>

Climate, Incames and energy price

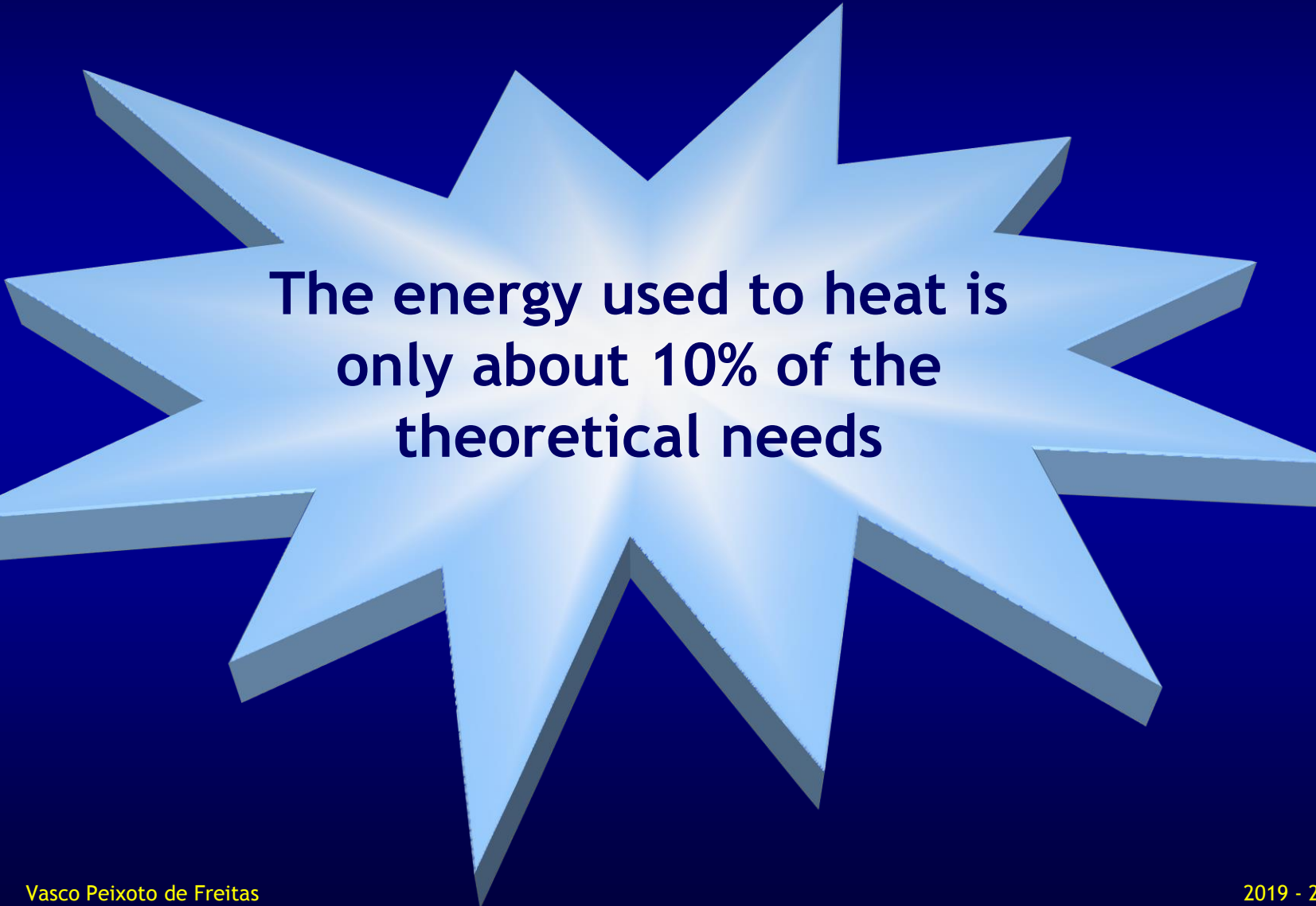
Indicators: Portugal vs. UE

Indicators	EU-27	Portugal	
Average temperature annual	8,2	15,7	+91%
HDD (2009)	3076	1166	-62%
Income (2014)	15 412	9 444	-39%
Energy Price: electricity gas	0,21/ 0,07	0,23/ 0,10	+9% +38%
% heating	67	21,5	-68%

Household energy consumptions - Portugal vs. Europe



PORTUGAL



The energy used to heat is
only about 10% of the
theoretical needs

Cultural aspects



Open the windows every morning

Energy efficiency or minimize the discomfort?

**This type of family does not
spend money on heating**

Which is the best strategy in this case?

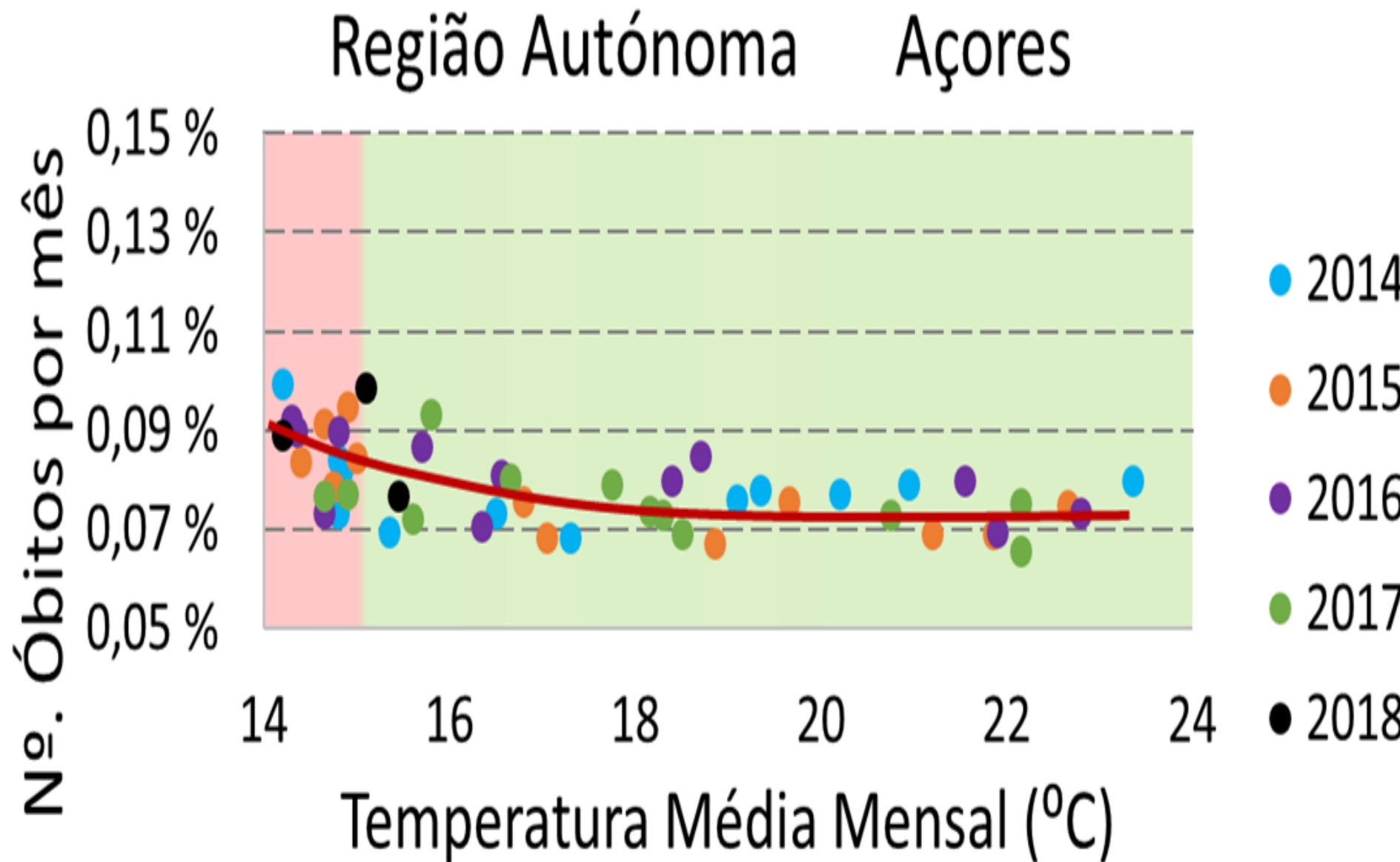


**Energy efficiency or
to minimize the
discomfort?**

3

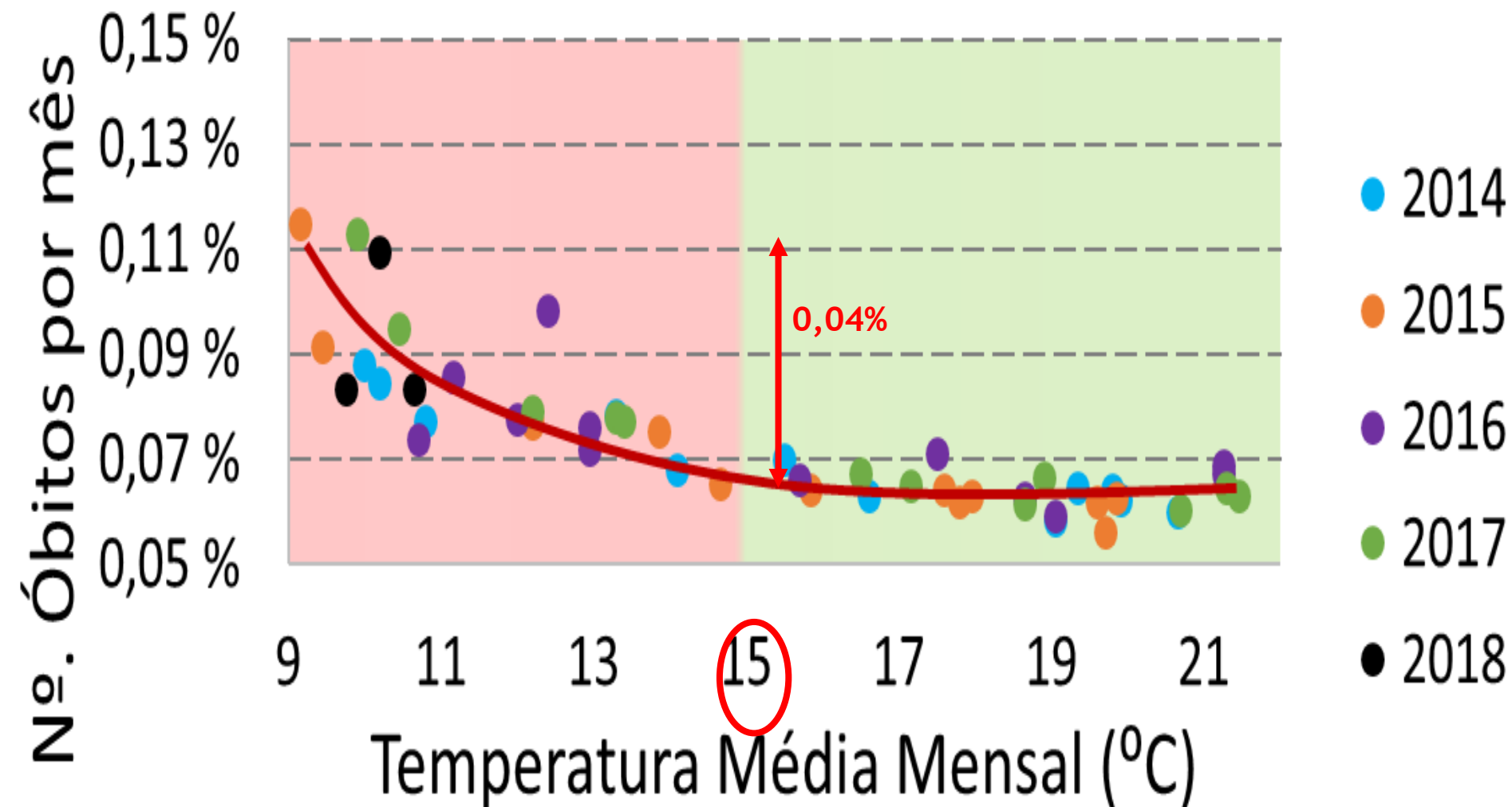
Discomfort and health in Social Housing

Exterior Temperature vs Mortality



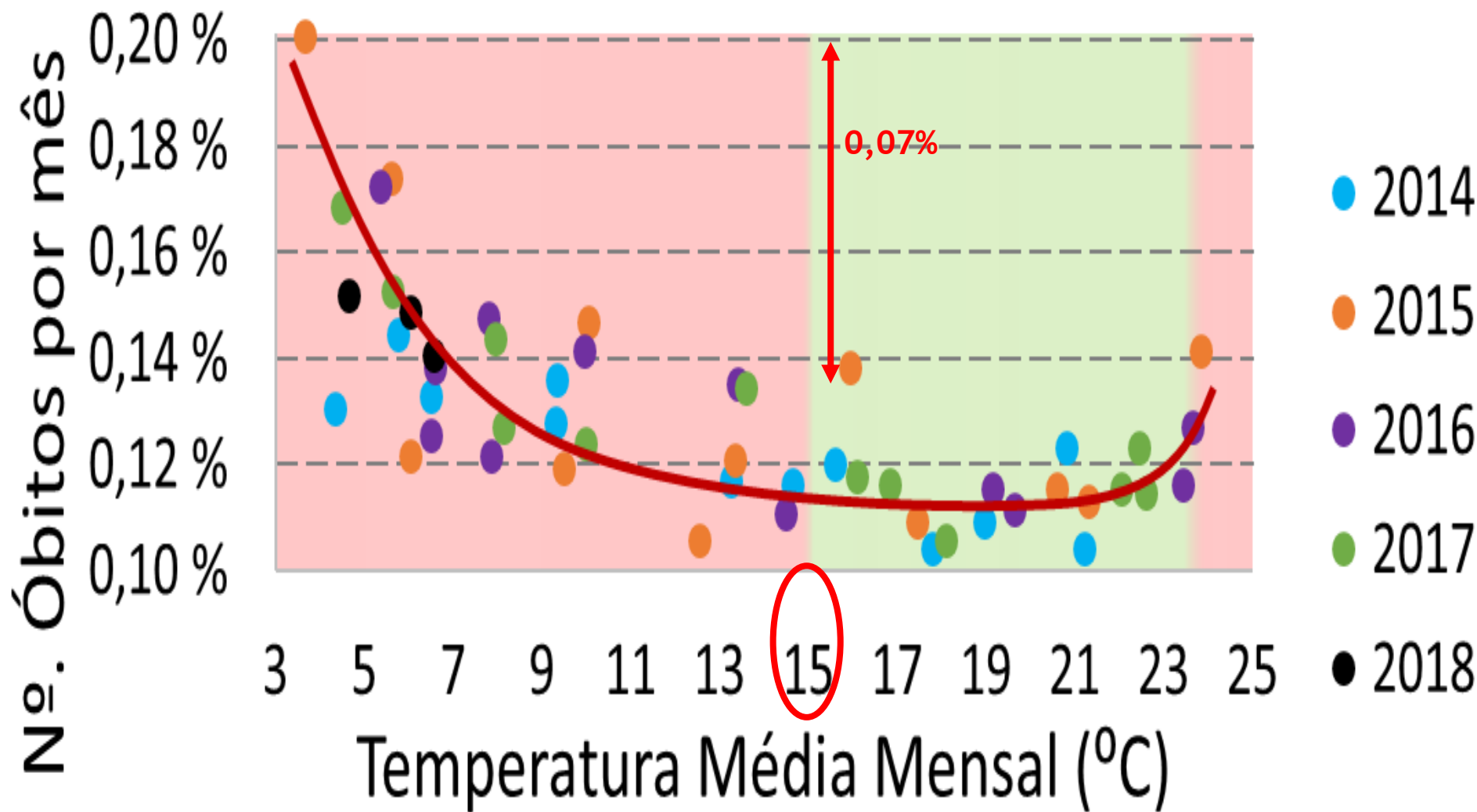
Exterior Temperature vs Mortality

Distrito do Porto



Exterior Temperature vs Mortality

Distrito de Bragança



4

Social Housing - New Buildings



- Proposal

Porto.



Southwest entrance

Porto.


AYTHYA
INVESTIMENTOS IMOBILIÁRIOS



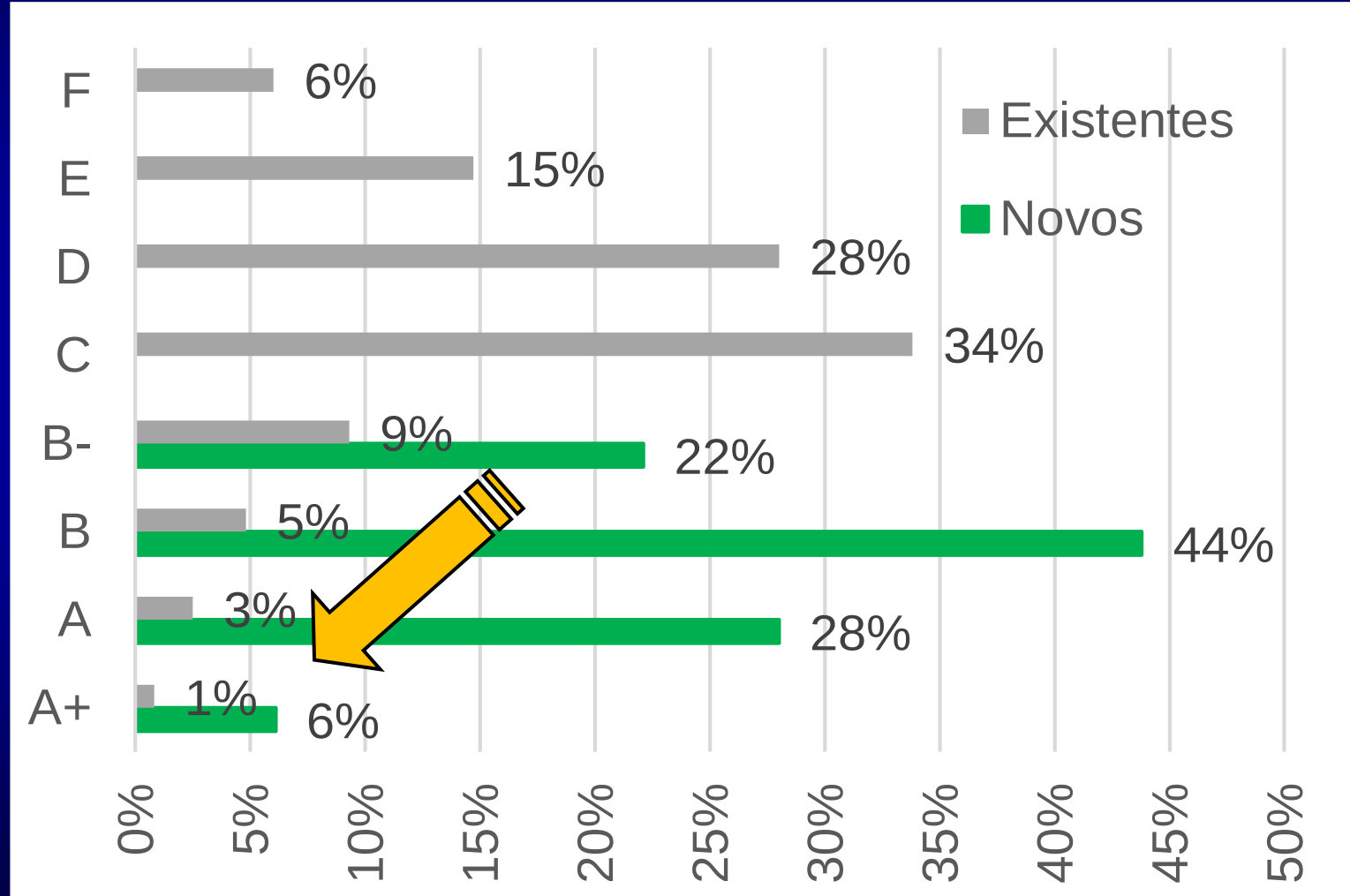


But it is very difficult to achieve...

A ≠

ENERGY CERTIFICATION A+ ?

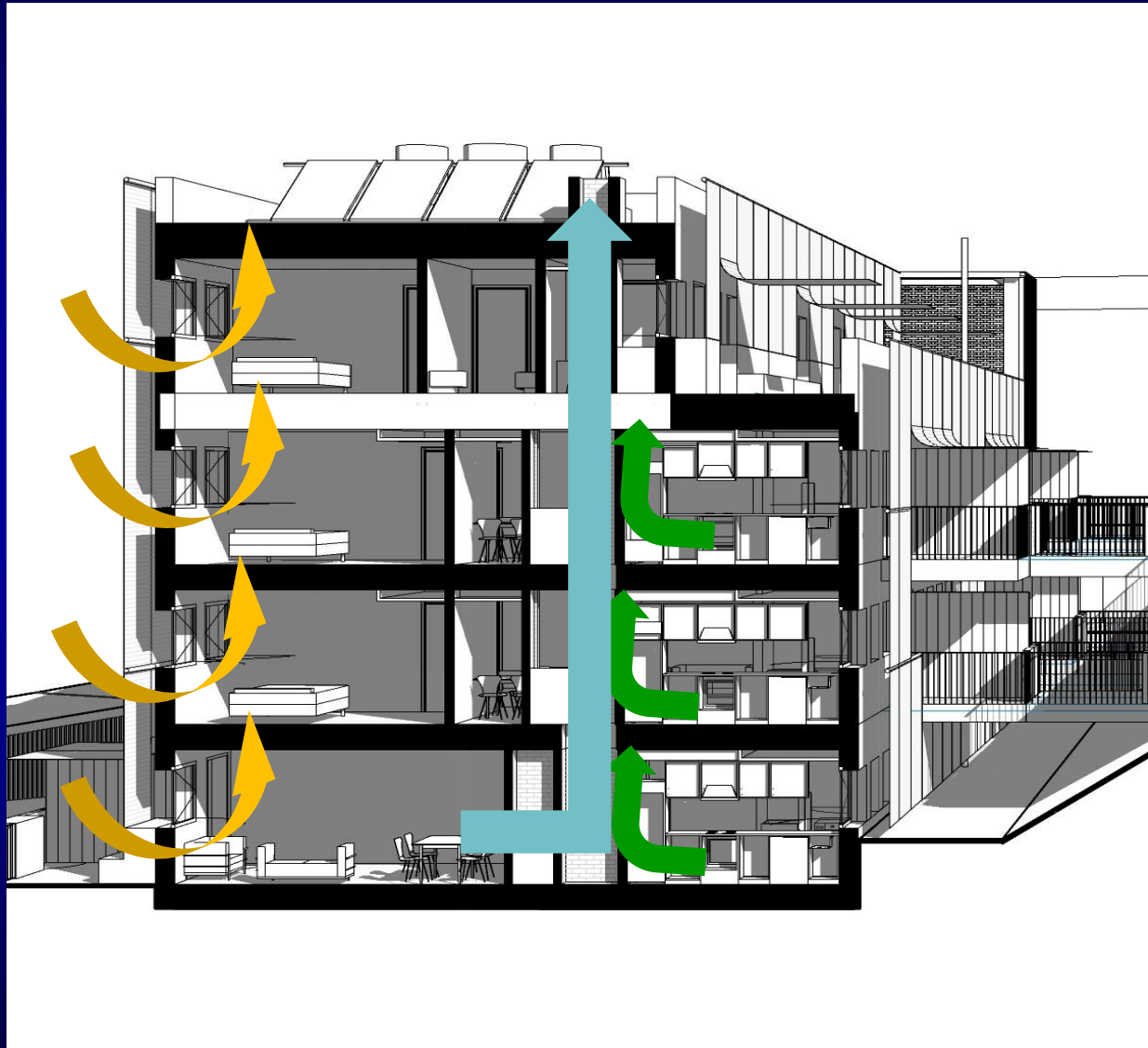
EPCs - new vs. existing



Solar protection - Shading

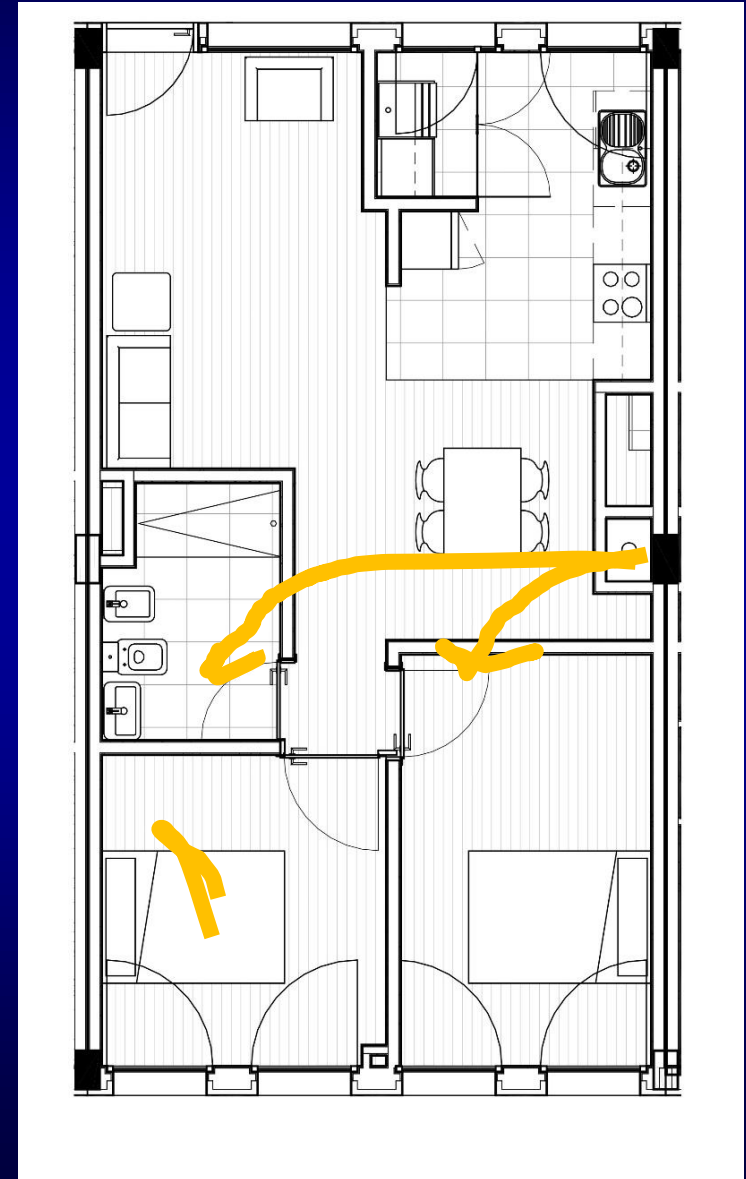


Ventilation - Principle

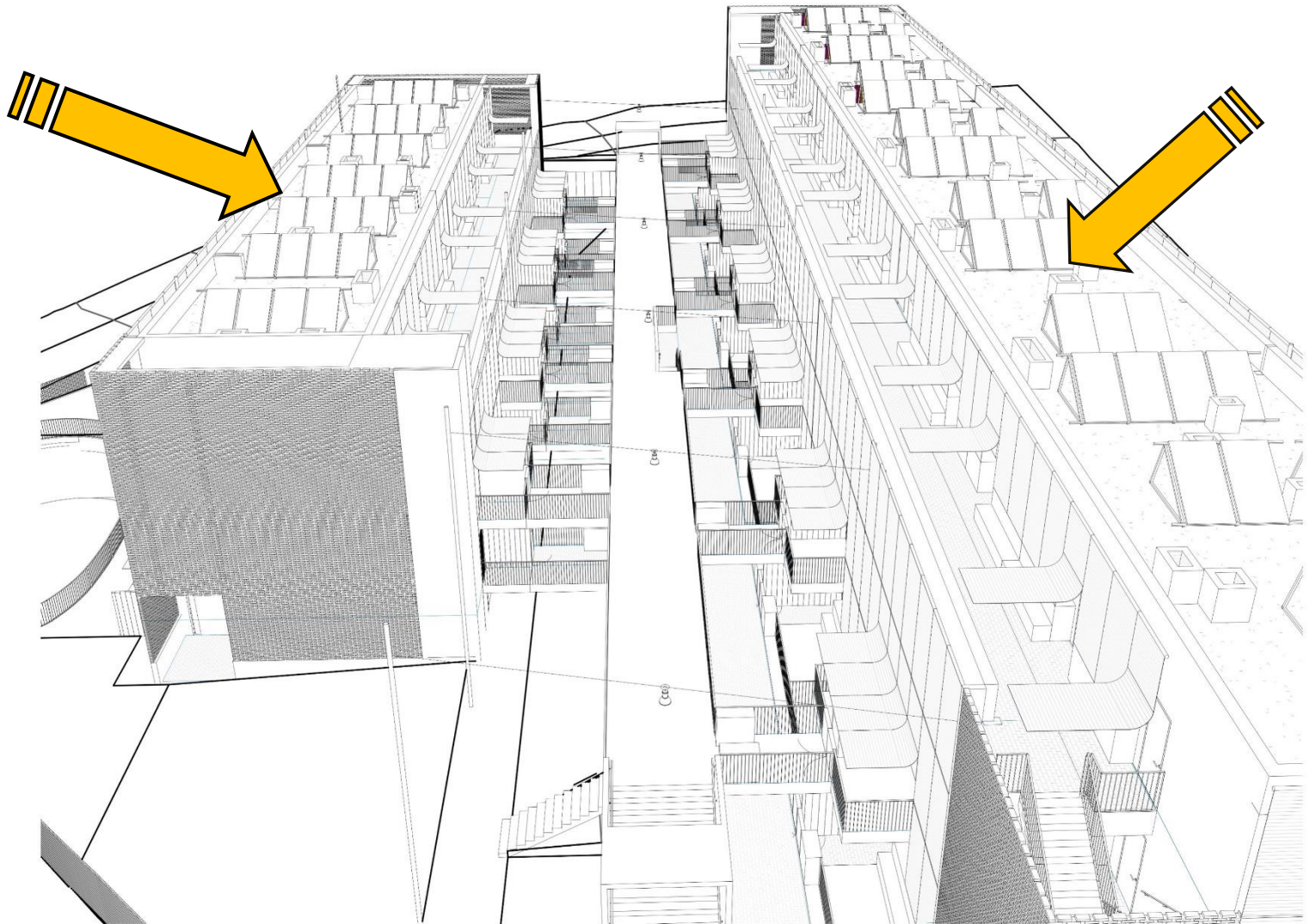


Heating - biomass

- ▷ Fireplace - living room
- ▷ Power - 8 kW
- ▷ Efficiency - 76%
- ▷ Ensures room heating



Renewable energy for sanitary water and heating - Solar Thermal Panels or PV Panels



Risk



Maintenance costs

5

Social Housing - Rehabilitation

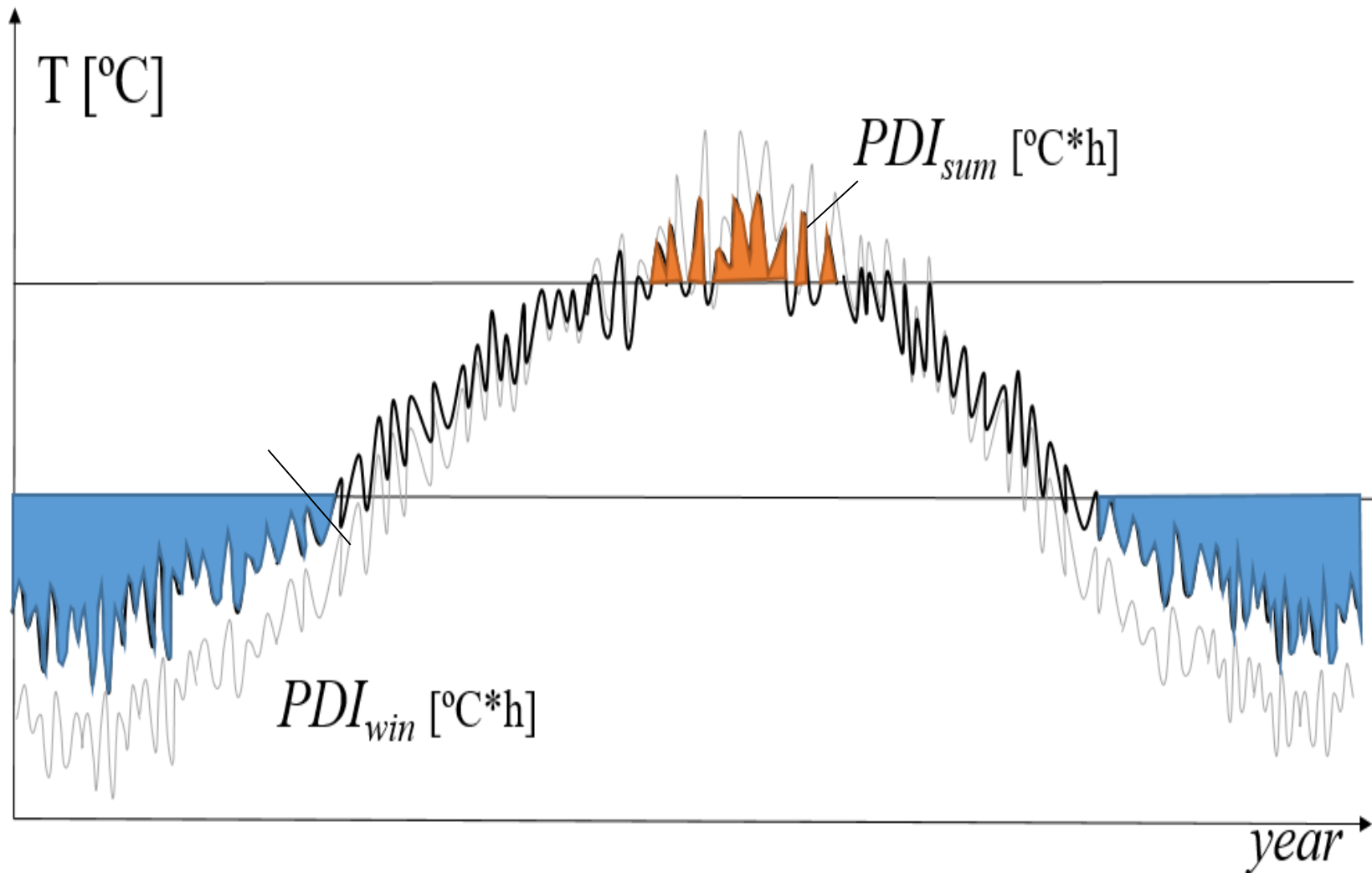
Rehabilitation - Social housing



Problem?

Differences between theoretical energy consumptions according to EPBD model and the actual energy household consumptions
(Southern European countries)

If intermittent heating/cooling is the practice energy efficiency is important, but more important is to minimize the discomfort

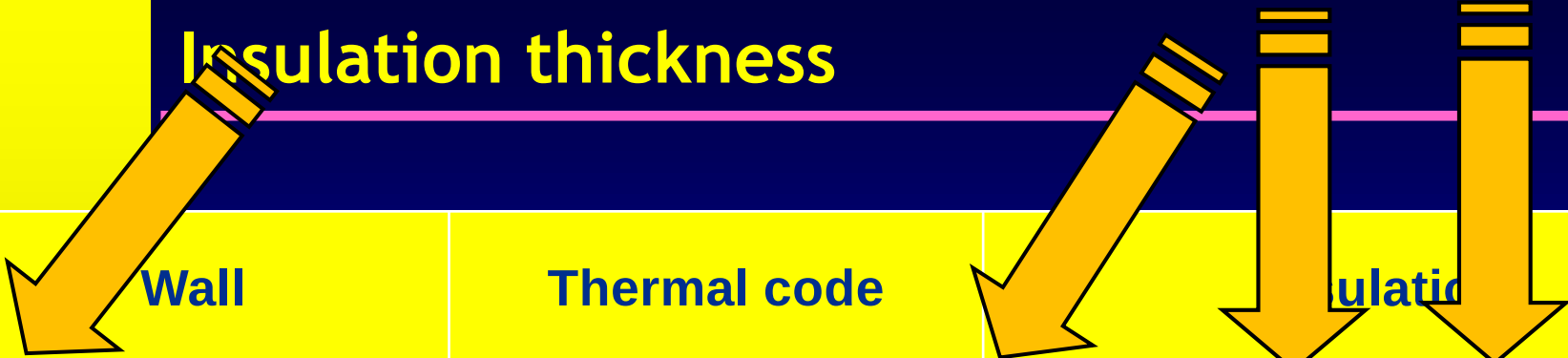


After 1st January 2016

Maximum U values

$U_{m\acute{a}x}$ [W/(m ² .°C)]		Zona climática		
Portugal Continental				
Zona corrente da envolvente:		A partir de 31 de dezembro 2015		
		I1	I2	I3
em contacto com o exterior ou com espaços não úteis com coeficiente de redução de perdas $b_{tr}>0.7$	Elementos opacos verticais	0,50	0,40	0,35
	Elementos opacos horizontais	0,40	0,35	0,30
Vãos envidraçados (portas e janelas) (U_w)		2,80		
Regiões Autónomas				
Zona corrente da envolvente:		A partir de 31 de dezembro 2015		
		I1	I2	I3
em contacto com o exterior ou com espaços não úteis com coeficiente de redução de perdas $b_{tr}>0.7$	Elementos opacos verticais	0,70	0,60	0,45
	Elementos opacos horizontais	0,45	0,40	0,35

Insulation thickness



Wall		Thermal code		Insulation		
$U_{PExistente}$ [W/m ² .°C]	$R_{PExistente}$ [m ² .°C/W]	$U_{Máx I2}$ [W/m ² .°C]	$R_{Mín I2}$ [m ² .°C/W]	$\Delta R I2$ [m ² .°C/W]	$e [m]$ $\lambda = 0,05$ [W/m.°C]	$e [m]$ $\lambda = 0,03$ [W/m.°C]
1,00	1,00	0,40	2,50	1,50	0,08	0,05
1,50	0,67	0,40	2,50	1,83	0,09	0,06
2,00	0,50	0,40	2,50	2,00	0,10	0,06
2,50	0,40	0,40	2,50	2,10	0,11	0,07

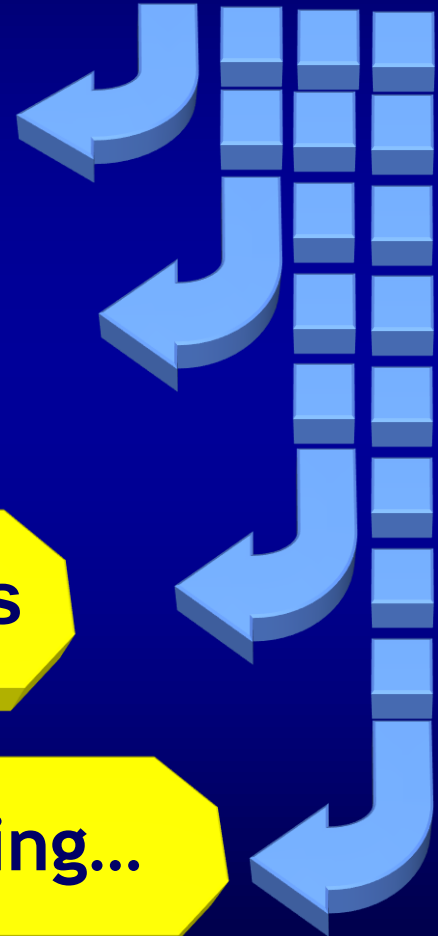
Important to understand...

Inappropriate impact of the same measures

Economic mistake in the real payback

Increase hygrothermal risks

Increase summer overheating...



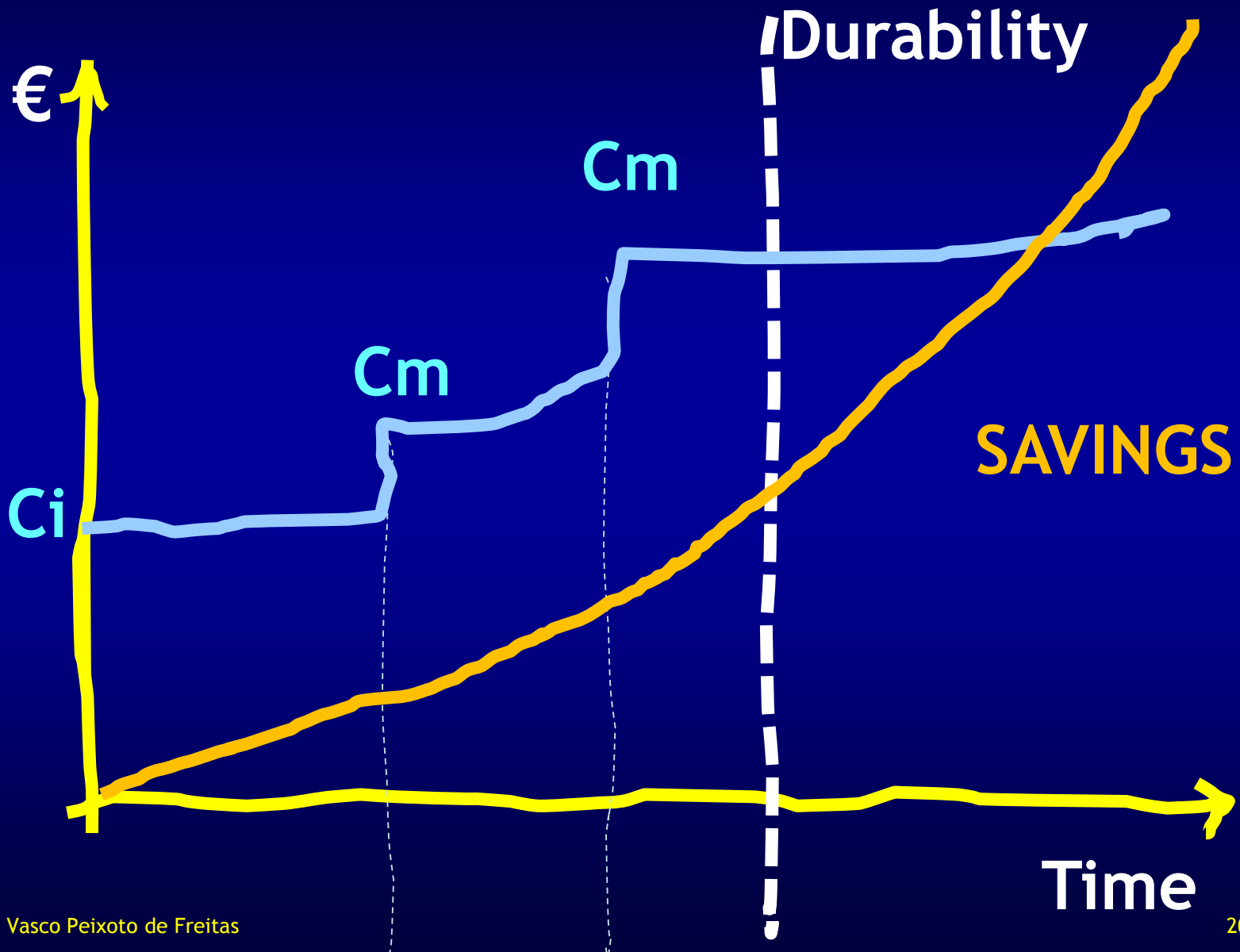
Economic mistakes in the payback calculation



Cost analysis

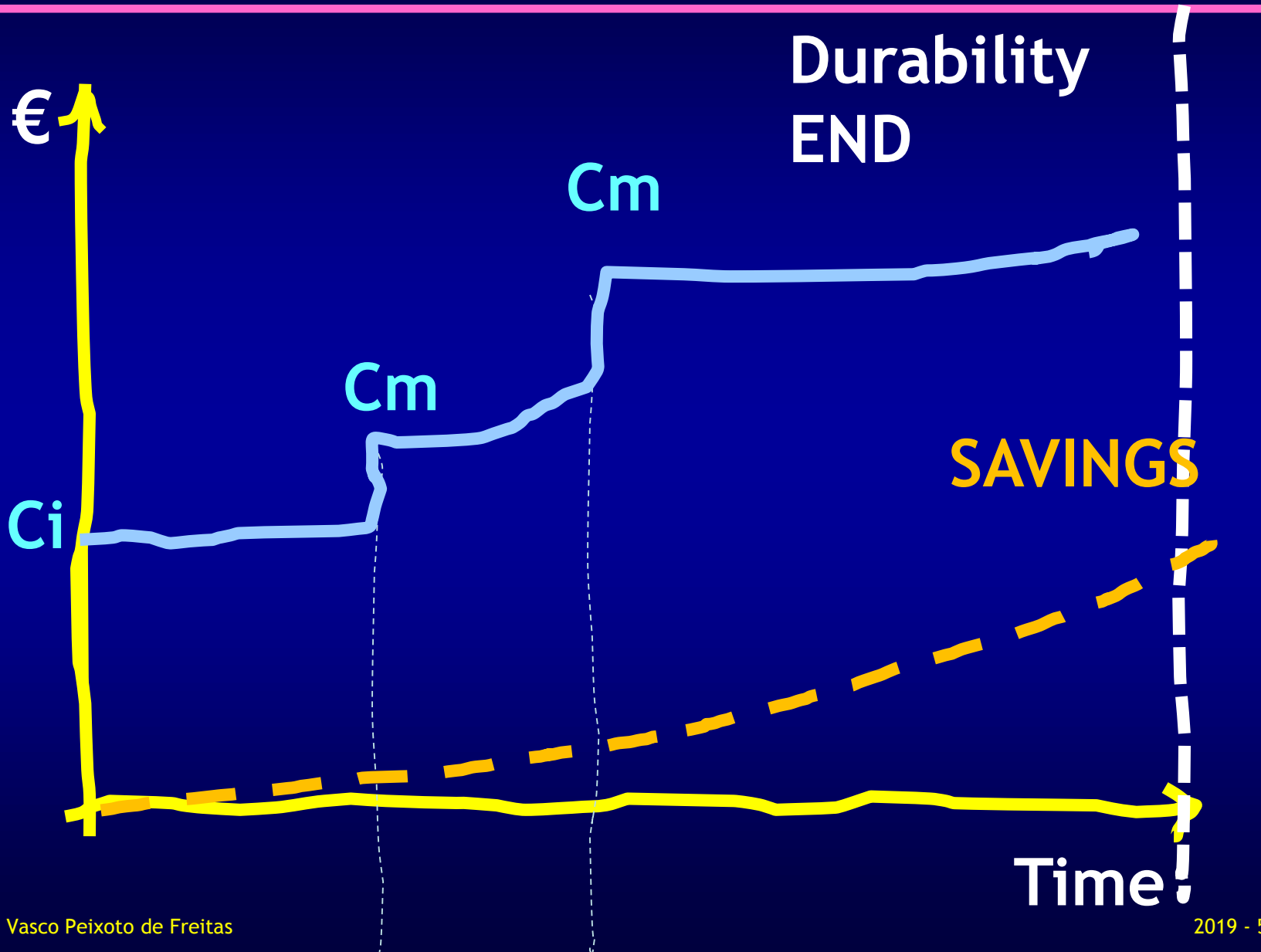


Durability



Intermittent or non-existent heating practice?

Payback



... my point of view ...

Energy efficiency is important ... but..

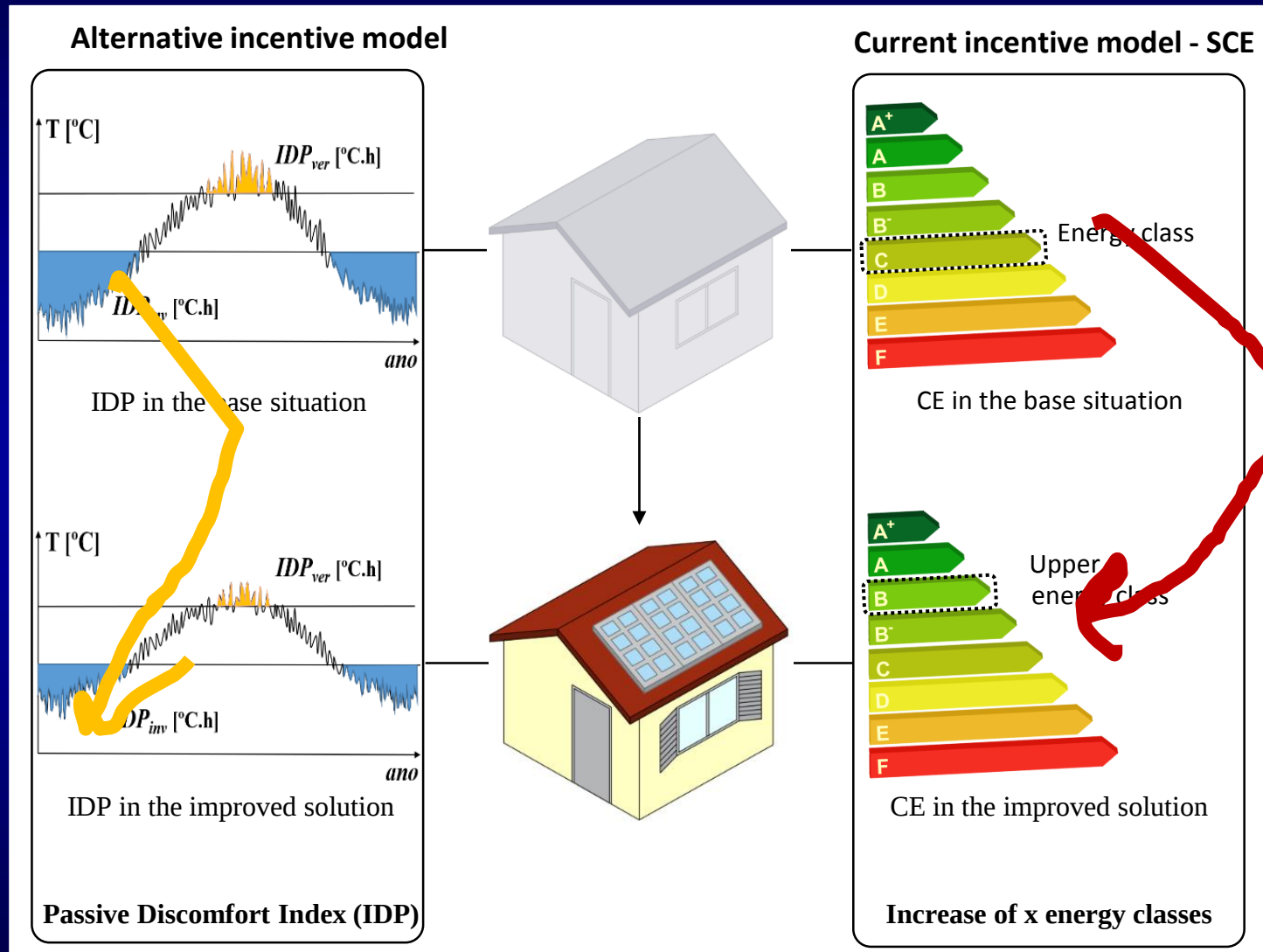


Alternative approach

Quantification of the discomfort minimization

Energy efficiency - Classic approach...

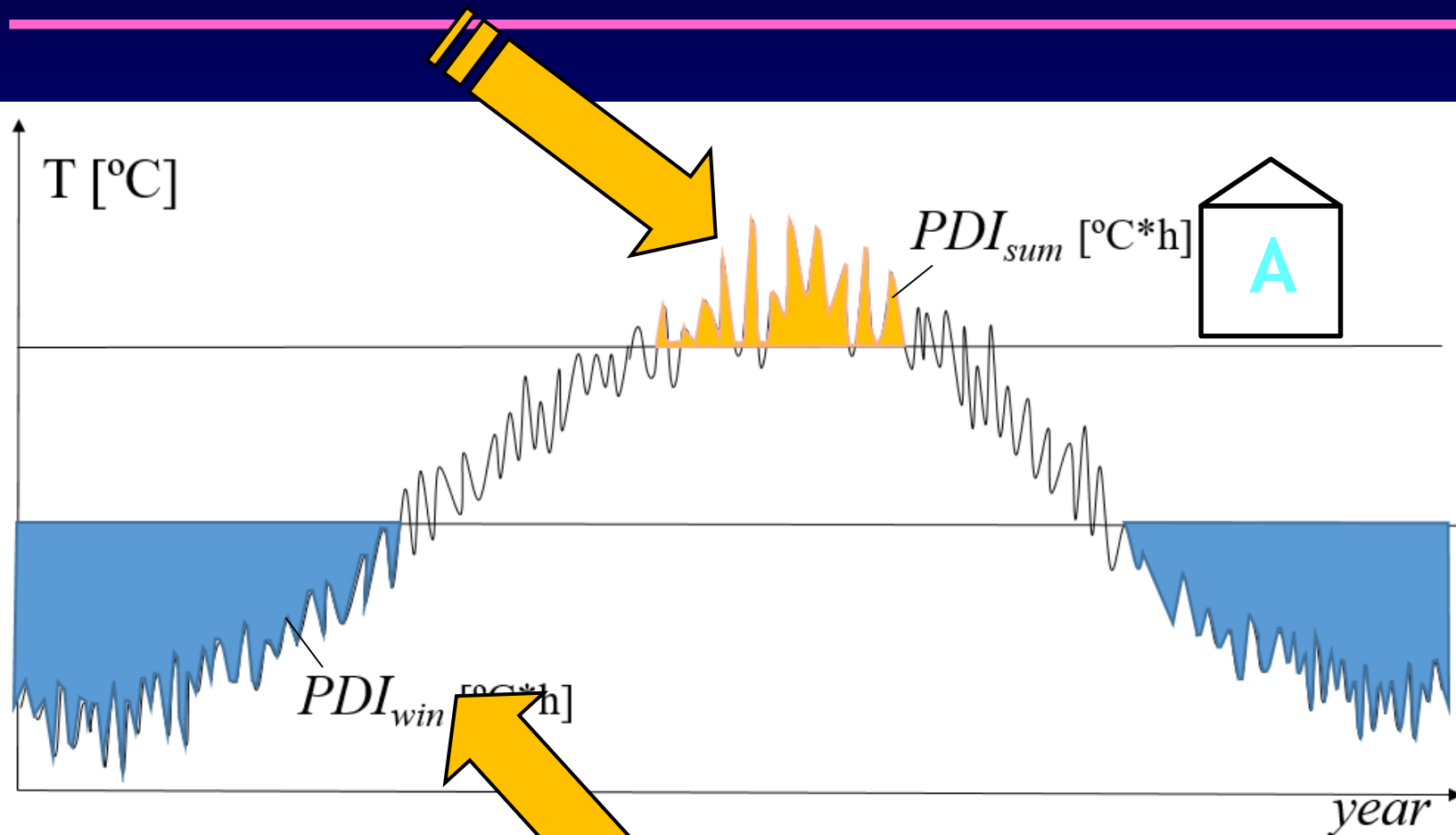
Minimization of the discomfort - Alternative



6

“PASSIVE DISCOMFORT INDEX” PDI definition

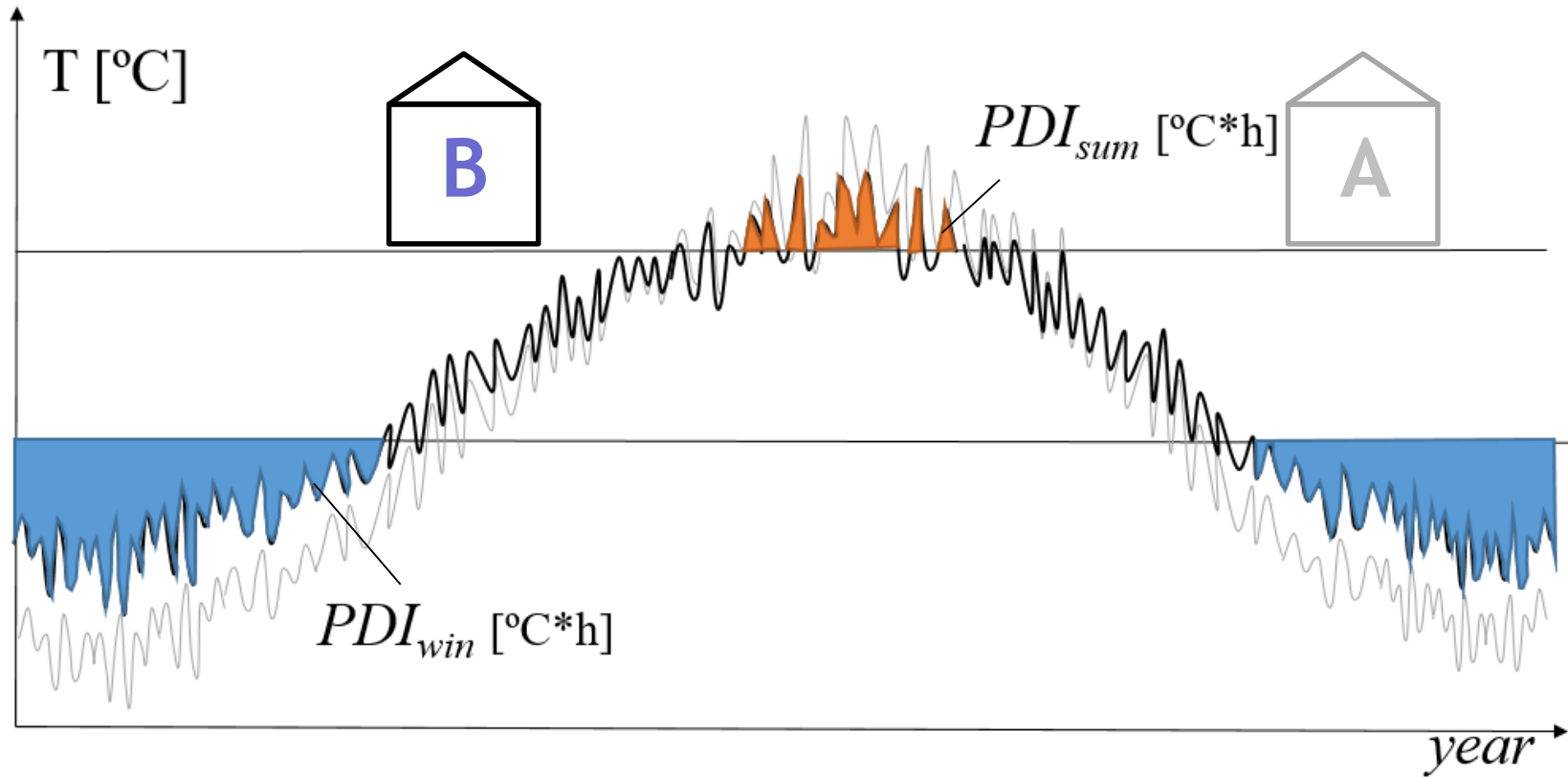
“Passive Discomfort Index” (PDI) definition - Empty house



$$PDI = \sum (T_{out} - T_{set}) \cdot h_{WIN} + \sum (T_{in} - T_{set}) \cdot h_{SUM}$$

$$PDI_{TOT} = PDI_{WIN} + PDI_{SUM}$$

“Passive Discomfort Index” (PDI) definition - Intermittent heating

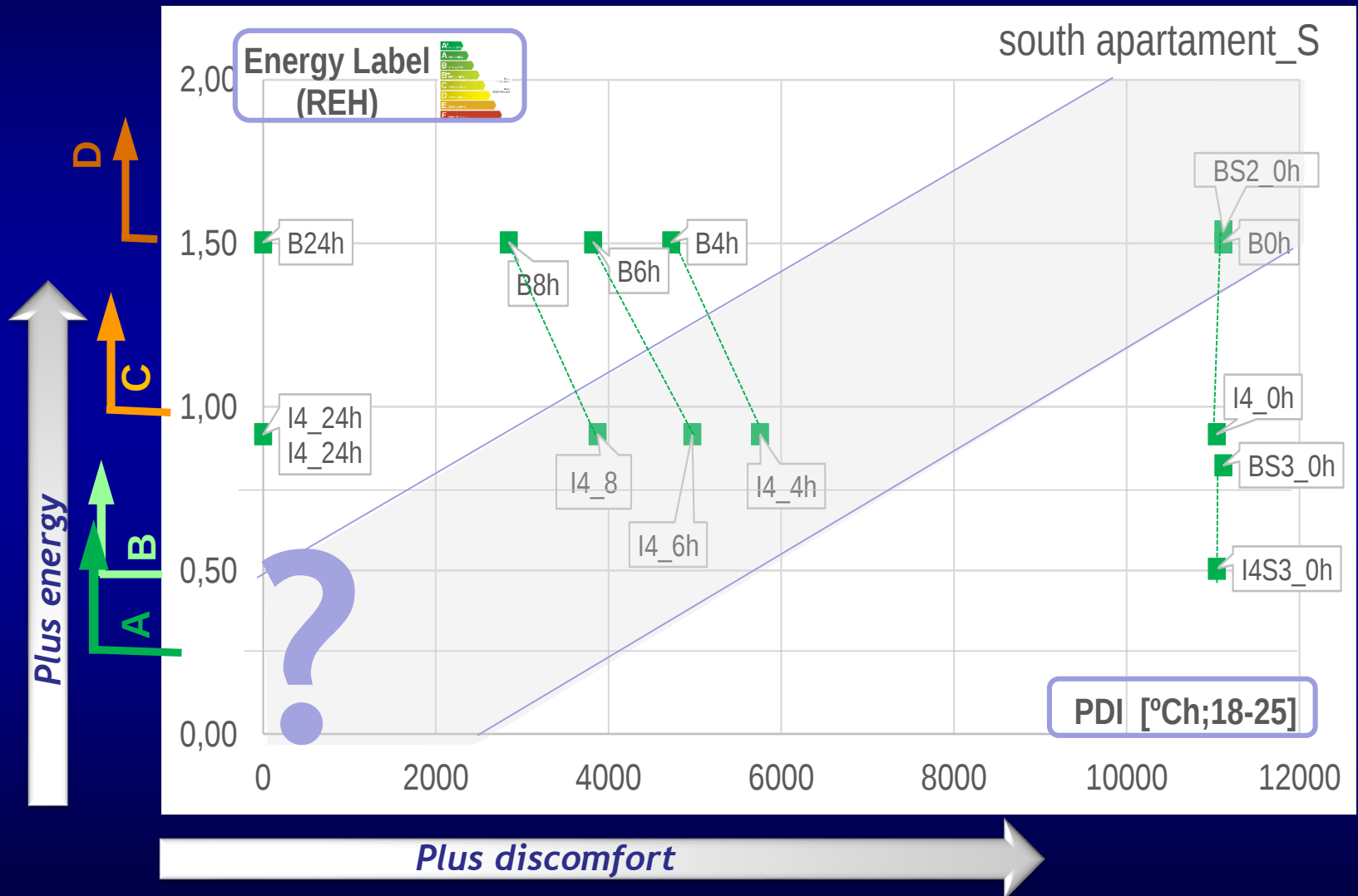


$$PDI = \sum (^{\circ}\text{C} \cdot h_{WIN}) + \sum (^{\circ}\text{C} \cdot h_{SUM})$$

$$PDI_{TOT} = PDI_{WIN} + PDI_{SUM}$$

NO CORRELATION between...

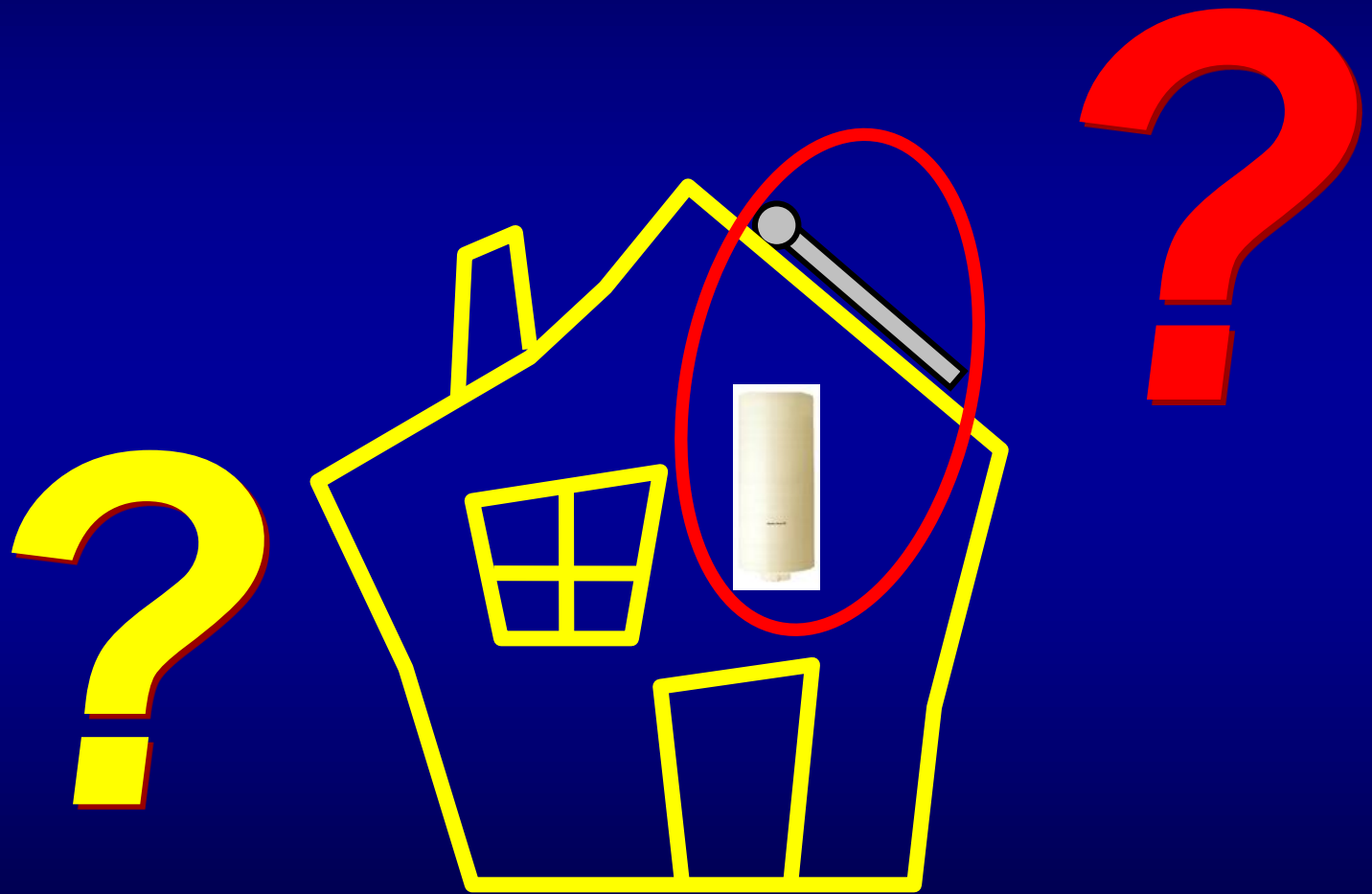
Passive Discomfort Index vs Energy Certification Label



7

CONCLUSIONS

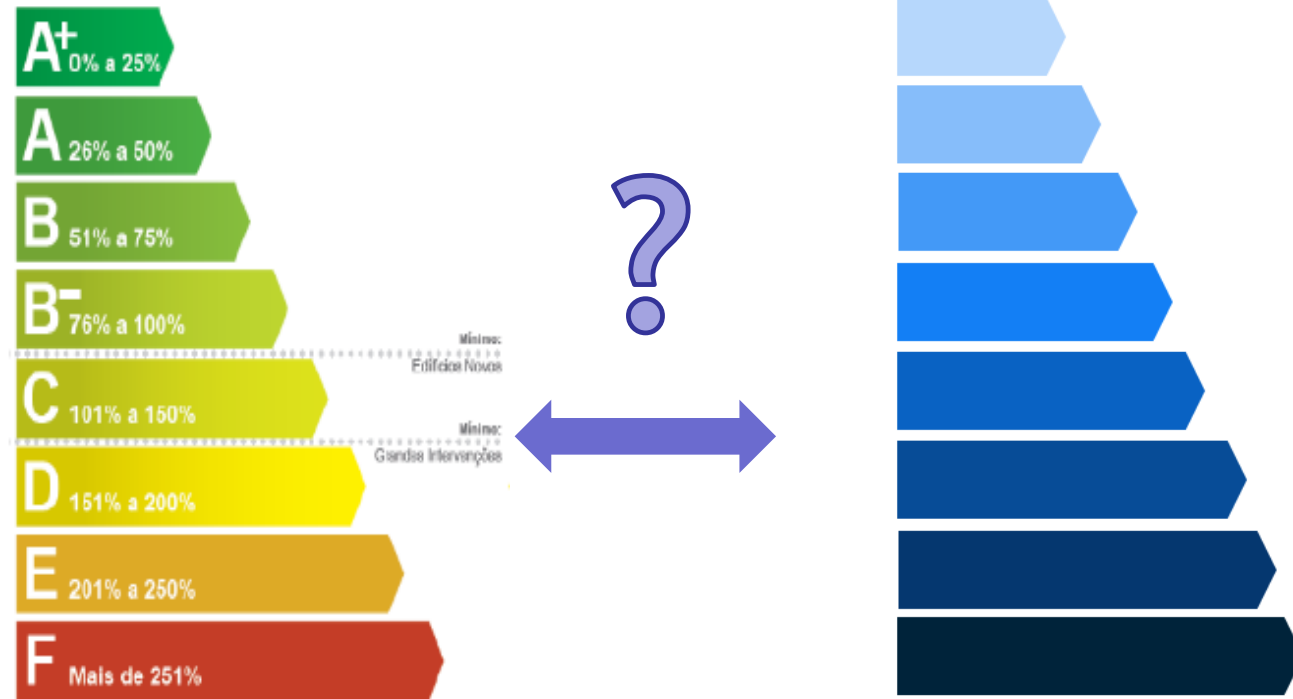
Envelope or equipment's



Designers have a narrow path to define the solutions in social housing (intermittent heating)



For some Southern European countries (PORTUGAL) it is important to promote a complementary index to Energy Certification Label



Energy Certification Label

Discomfort Passive index

Thank you very much for your attention....



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