The impact of the standby consumption in a Passive House

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Index

The first Certified Passive Houses in Portugal

- Project began in 2008 – not designed as a Passive House
- Construction started in May 2011 – as well as the adaptation to PH standard
- Construction concluded in November 2012

The first Certified Passive Houses in Portugal

Specific building characteristics with reference to the treated floor area					Criteria	Alternative criteria	Fullfilled?[2]
	Treated floor area	m²	223,7				
Space heating	Heating demand	kWh/(m²a)	7	≤	15	-	yes
	Heating load	W/m²	9	≤	-	10	
Space cooling	Cooling & dehum. demand	kWh/(m²a)	-	≤	-	-	-
	Cooling load	W/m²	-	≤	-	-	
	Frequency of overheating (> 25 °C)	%	0	≤	10		yes
	Frequency excessively high humidity (> 12 g/kg)	%	1	≤	20		yes
Airtightness	Pressurization test result n_{50}	1/h	0,5	≤	0,6		yes
Non-renewable Primary Energy (PE)	PE demand	kWh/(m²a)	53	≤	-		-
Primary Energy Renewable (PER)	PER demand	kWh/(m²a)	24	≤	60	60	yes
	Generation of renewable energy	kWh/(m²a)	14	≥	-	-	

[2] Empty field: Data missing; '-': No requirement

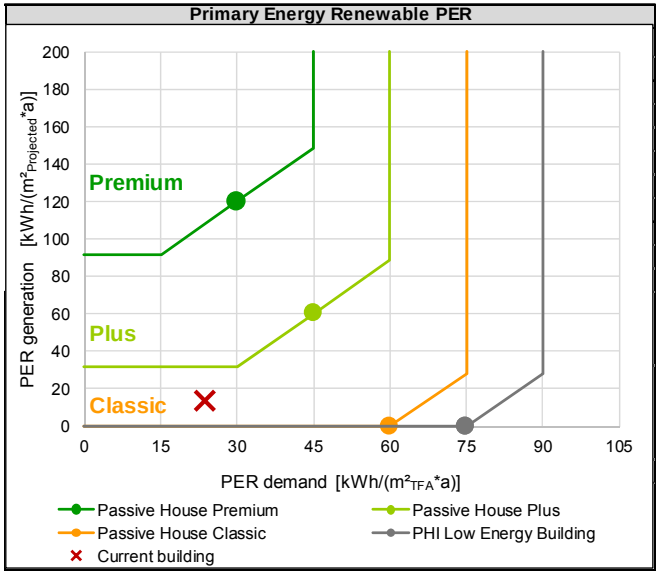
PHPP 9 results

Classic

Certified Passive House
Passive House Institute
classic | plus | premium

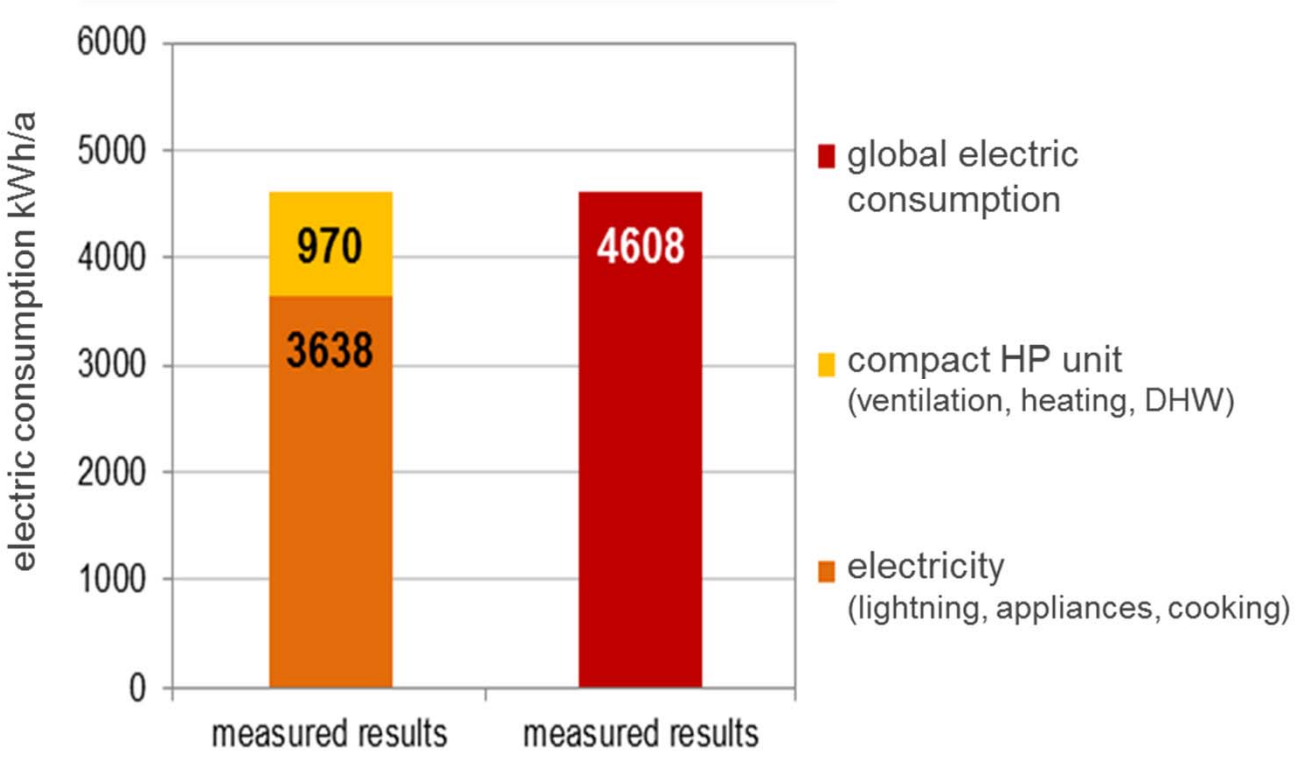
Renewable primary energy demand
[$kWh_{PER}/(m^2_{TFA}*a)$]

≤ 60



The first Certified Passive Houses in Portugal

Monitoring of electrical consumption (2014)



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Current situation (2016):

Installation of 6 PV panels with an annual production of 2100 kWh

Plus

Renewable energy generation
[$kWh_{PER}/(m^2_{ground}*a)$]

≥ 60

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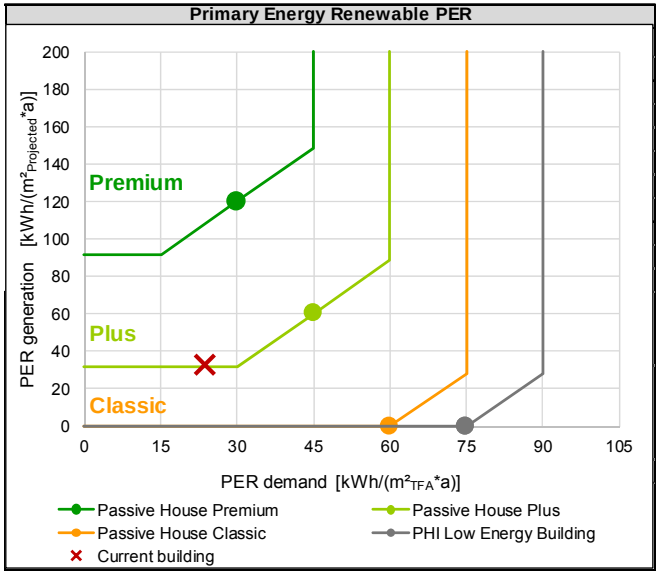
Renewable primary energy demand
[$kWh_{PER}/(m^2_{TFA}*a)$]

≤ 45



This Passive House meets the criteria for the Passive House Plus class.

Standby - definition

Standby power is a general term commonly used to describe **the low power mode(s)** that many electrical and electronic products are in **when not performing their main function**.

according to International Energy Agency

standby mode: the appliance **fulfils at least one function** but not the main purpose — **60%** **of all standby losses**

off mode: the appliance **does not fulfil any task**, seems to be switched off but still uses energy. — **30%** **of all standby losses**

Standby - history

- Standby energy was really only **identified in** the **mid 1980's**.
- Standby energy is now **one of the largest individual electrical end uses** in the residential sector (more or less 10 %).
- Standby energy now represents one of the **largest potential energy savings** in the residential sector.
- There is growing international concern about the impacts of all energy consumption on climate change. There is a **need for urgent action to reduce standby energy**.

source: IEA, 2010

305 kWh/year is the average standby consumption in European households, corresponding to:

11% of the total annual electricity consumption;

40 W standby power per household;

50 % (more or less) of the electronic loads consumption;

75 TWh/year of electricity wasted in EU-27 private households and offices;

13 000 million € spent with no return;

source: REMODECE, 2007 (Residential Monitoring to Decrease Energy Use and Carbon Emissions - IEEA Programme)

In 2013…

616 TWh of standby consumption in World´s private households and offices, corresponding to:

59 000 million € spent with no return;

…and by 2030…

15 % of the total electricity consumption in Europe could be due to standby functions

source: IEA (International Energy Agency), 2014

What about in Germany…

…in 2004…

22 TWh of standby consumption in private households and offices, corresponding to:

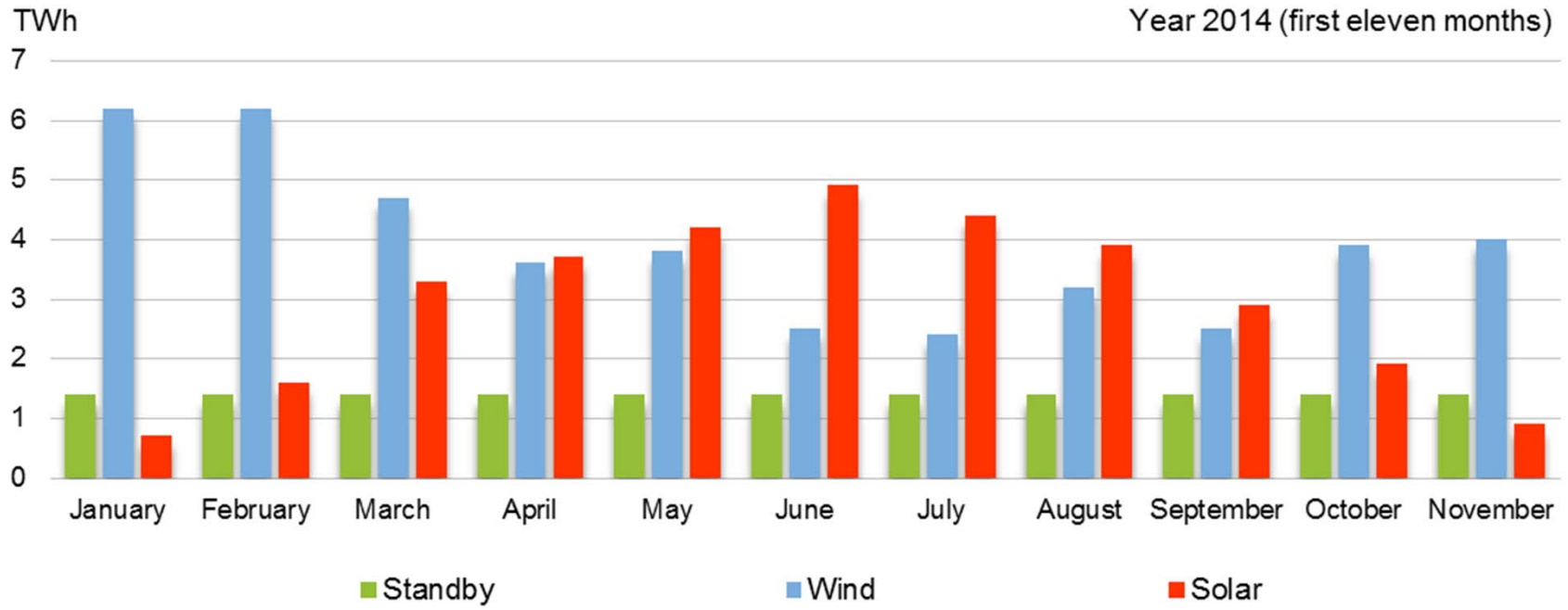
4 000 million € spent with no return;

Let's compare it with the renewable energy generated…

source: UBA (German Federal Environment Agency), 2008

Standby savings and the renewables generation

In 2014, a reasonable and achievable **mitigation** of **75% of standby** consumption in **Germany would induce savings** of **15,4 TWh**, an average of **1,4 TWh** per month.

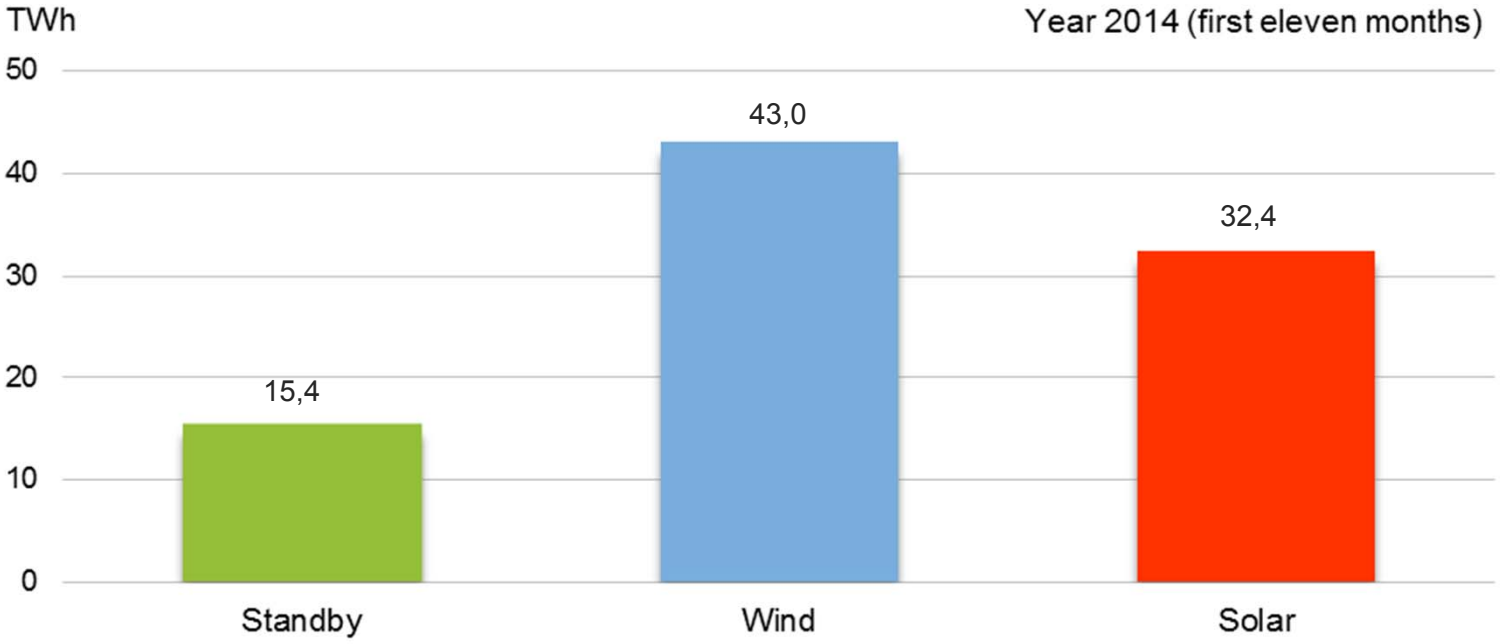


source: Fraunhofer ISE, 2014

Standby savings and the renewables generation

The amount of **standby savings**, **15,4 TWh** of final energy, are equivalent to the following amounts:

- **53 %** of **total electricity** produced from **solar** (PE);
- **40 %** of **total electricity** produced from **wind** (PE).



source: Fraunhofer ISE, 2014

Standby mitigation - regulation

What is the European Union doing?

EU established demanding limits to manufacturers to reduce the standby consumptions of their equipment.

Modes	Limits (W) *
Off-mode	**0,5**
Standby – with no display	**0,5**
Standby – with display	**1,0**

** products placed on market from January 2013*

source: EuP Directive (Energy-Using Product, 2014)

Standby mitigation - solutions

Simple, cheap & DIY solutions

Standby mitigation - solutions

Monitoring tools




Mitigation tools









Automatic mitigation tools





More solutions available everywhere!

Standby in the first Passive House in Portugal Methodology

1. **Monitoring the standby** consumption
   - **Each equipment** was monitored **in its different modes**, in June 2015, with **an energy meter** with a resolution of 0,1 PeakTech 9035, based on previous monitor realized with Cloogy and Owl online monitor systems.
2. The **data** was **organized** and **analyzed**
   - It was **set the number of hours of utilization for each equipment** for the different modes, based on the family behavior pattern.
3. **Mitigation scenarios**
   - **1st Scenario**: based on the **utilization** of the most **relevant solutions** which are nowadays **available on the market**.
   - **2nd Scenario**: based on the **limits set for each device** (by new **EU regulations**) for the standby and off mode consumption.

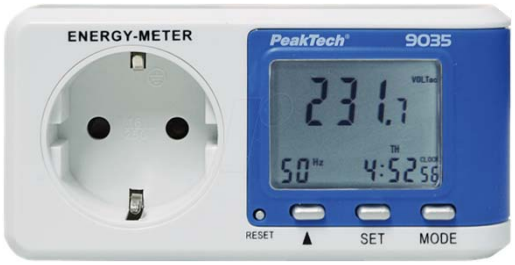
source: Fraunhofer ISE, 2014

Standby in the first Passive House in Portugal

Monitoring - "get awareness to the problem"

Monitoring tools

energy meter



19€

online monitor systems

75€

Panel near the front door

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Standby in the first Passive House in Portugal
Data analysis

Application	Nº	Standby average consumption (*)	Off-Mode consumption	Off-Mode (h/d)	Standby consumption	Standby (h/d)	days / year		Off-Mode & Standby Consumption kWh/a			
TV	1	5.1	2.0	18.0	2.0	2.0	365	=	14.6	1.8%		
DVD player	1	1.5	0.9	18.0	1.5	2.0	365	=	7.0	0.9%		
Sound System	1	8.3	0.9	18.0	2.0	1.0	365	=	6.6	0.8%		
Set-top Box, digital cable	1	17.5	13.7	18.0	13.7	2.0	365	=	100.0	12.1%	15.6%	128.3
Laser printer	1	1.6	0.9	15.0	8.9	5.0	365	=	21.2	2.6%		
Monitors	2	1.4	0.9	15.0	0.9	5.0	365	=	13.1	1.6%		
Notebook	3	8.9	0.9	15.0	0.9	5.0	365	=	19.7	2.4%	6.6%	54.0
Dishwashing	1		0.1	17.0	3.4	5.0	365	=	6.8	0.8%		
Induction Ceramic Cooktop	1	3.0	1.2	20.0	1.2	0.0	365	=	8.8	1.1%		
Electrical Oven	1	1.8	1.4	23	1.4	0.0	365	=	11.8	1.4%		
Microwave oven	1	3.1	2.3	20	2.3	3.5	365	=	19.7	2.4%		
Refrigerating	1				0.8	20	365	=	5.8	0.7%		
Freezing	1				0.5	20	365	=	3.7	0.4%		
Clothes washing	1		0.1	17.0	2.6	3.0	365	=	3.5	0.4%	7.3%	60.0
Garage Door opener	1	4.5	4.9	23.8	4.9	0.0	365	=	42.6	5.2%		
Door opener	1	4.5	2.9	23.8	2.9	0.0	365	=	25.2	3.1%	8.2%	67.8
Compact Unit: NILAN compact P	1		9.6	24.0	9.6	0.0	213	=	49.1	6.0%		
Solar Tank	1				1.3	12.0	365	=	5.7	0.7%	6.6%	54.8
Control of electrical shutters	22				2.4	23.8	365	=	458.7	55.7%	55.7%	458.7
Total								kWh	823.5	100%	100%	
Specific demand	tfa = 223 m^2							kWh/(m^{2}a)	3.69			

(*) Lawrence Berkeley National Laboratory: Standby Power Summary Table

Standby in the first Passive House in Portugal
Data analysis

The total standby consumption measured was **823,5 hWh/a** and it corresponds to:

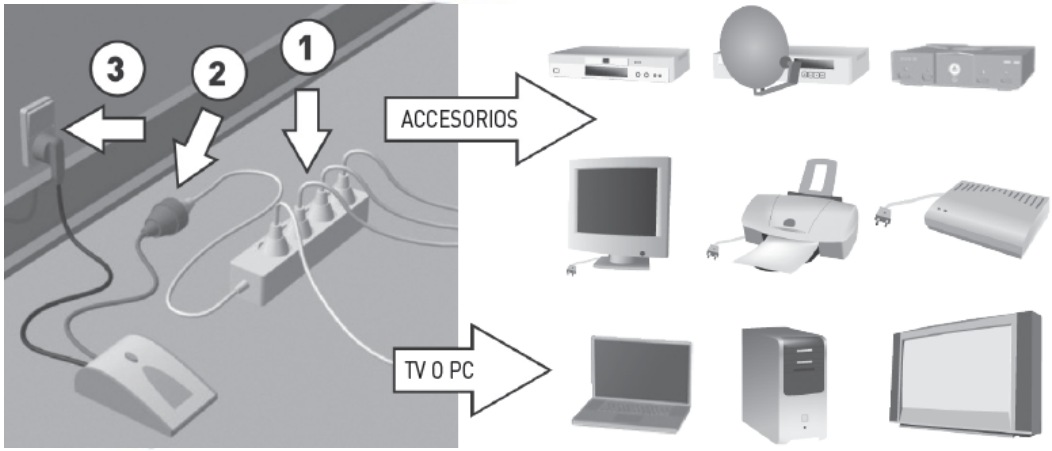
- **17,9 %** of the **total measured energy consumption**
- **13,4 %** of the **final energy obtained with the PHPP 9**

The only energy source is electricity.

Standby in the first Passive House in Portugal
Identify the problems – choose the solutions

1st problem: TV, DVD player, Sound system, Set-top Box

Application	Nº	Off-Mode & Standby Consumption kWh/a
TV	1	14.6
DVD player	1	7.0
Sound System	1	6.6
Set-top Box, digital cable	1	100.0
Annual consumption (kWh)		128.3
Annual mitigation (kWh)		128.3
Cost of electricity per KWh (€) (1)		0.21
Cost of annual consumption (€)		26.93
Aquisition of standby mitigator (€)		29.00
Payback (years)		1.1

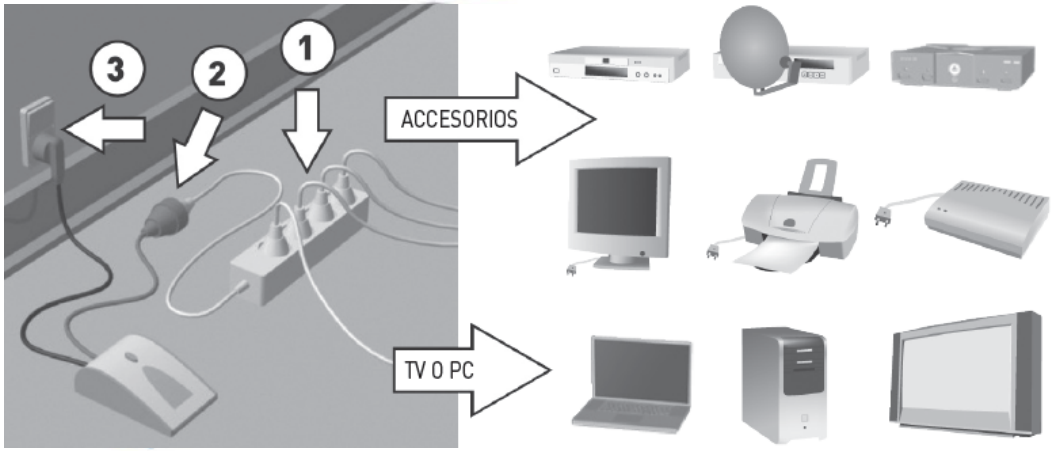


(1) Eurostat, 2014 (EU-28 Electricity prices for household consumers, second half 2014, with taxes and VAT)

Standby in the first Passive House in Portugal
Identify the problems – choose the solutions

2nd problem: Printer, Monitors, Notebooks

Application	Nº	Off-Mode & Standby Consumption kWh/a
Laser printer	1	21.2
Monitors	2	13.1
Notebook	3	19.7
Annual consumption (kWh)		54.0
Annual mitigation (kWh)		54.0
Cost of electricity per KWh (€) (1)		0.21
Cost of annual consumption (€)		11.34
Aquisition of standby mitigator (€)		29.00
Payback (years)		2.6



(1) Eurostat, 2014 (EU-28 Electricity prices for household consumers, second half 2014, with taxes and VAT)

Standby in the first Passive House in Portugal
Identify the problems – choose the solutions

3rd problem: Kitchen appliances.

Application	Nº	Off-Mode & Standby Consumption kWh/a
Dishwashing	1	6.8
Induction Ceramic Cooktop	1	8.8
Electrical Oven	1	11.8
Microwave oven	1	19.7
Refrigerating	1	5.8
Freezing	1	3.7
Clothes washing	1	3.5
Annual consumption (kWh)		60.0
Annual mitigation (kWh)		40.2
Cost of electricity per KWh (€) (1)		0.21
Cost of annual consumption (€)		8.45
Aquisition of standby mitigator (€)		30.00
Payback (years)		3.6

1 x Standby switch

1 x contactor

disconnector

This solution allows the **mitigation of 67%** of the **standby consumption.**

(1) Eurostat, 2014 (EU-28 Electricity prices for household consumers, second half 2014, with taxes and VAT)

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Standby in the first Passive House in Portugal
Identify the problems – choose the solutions

4th problem: Control of Window shutters.

Application	Nº	Off-Mode & Standby Consumption kWh/a
Control of electrical shutters	22	458.7
Annual consumption (kWh)		458.7
Annual mitigation (kWh)		458.7
Cost of electricity per KWh (€) (1)		0.21
Cost of annual consumption (€)		96.32
Aquisition of standby mitigator (€)		100.00
Payback (years)		1.0

1 x Standby switch


3 x contactors


disconnector


Control of shutters

The use of controls that consume **1 W** in **standby** would still **represent 191** kWh/a.

(1) Eurostat, 2014 (EU-28 Electricity prices for household consumers, second half 2014, with taxes and VAT)

Standby in the first Passive House in Portugal
Identify the problems – choose the solutions

5th problem: Control of garage door opener.

Application	Nº	Off-Mode & Standby Consumption kWh/a
Garage Door opener	1	42.6
Door opener	1	25.2
Annual consumption (kWh)		67.8
Annual mitigation (kWh)		35.5
Cost of electricity per KWh (€) (1)		0.21
Cost of annual consumption (€)		7.45
Aquisition of standby mitigator (€)		9.00
Payback (years)		1.2

1 x analog socket switch clock

This solution allows the **mitigation of 83%** of the **standby consumption.**

(1) Eurostat, 2014 (EU-28 Electricity prices for household consumers, second half 2014, with taxes and VAT)

Standby in the first Passive House in Portugal Results

The total estimated standby mitigation is **716,7 hWh/a** and it corresponds to:

- **15,5 %** of the **total measured energy consumption**
- **11,6 %** of the **final energy obtained with the PHPP 9**

The only energy source is electricity.

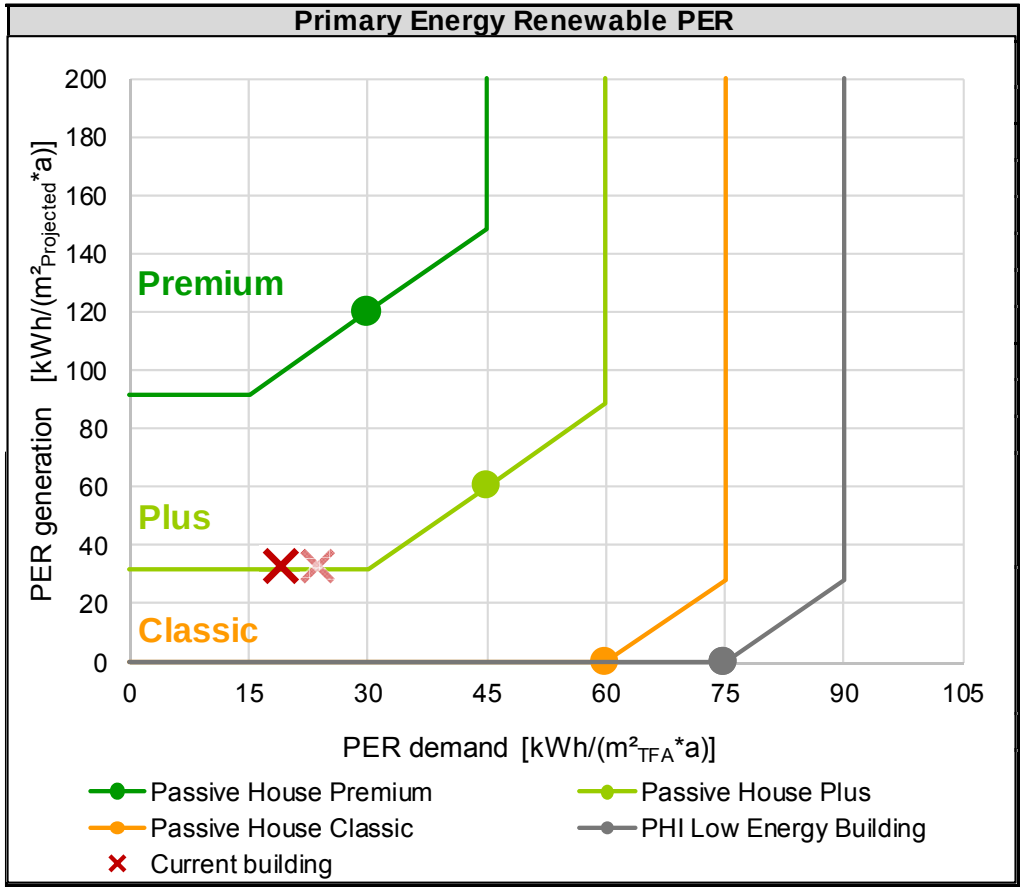
Standby in the first Passive House in Portugal Results

The remaining estimated standby consumption is **106,8 hWh/a** and it corresponds to:

- **2,7 %** of the **remaining measured energy consumption**
- **2,0 %** of the **remaining final energy obtained with the PHPP 9**

The only energy source is electricity.

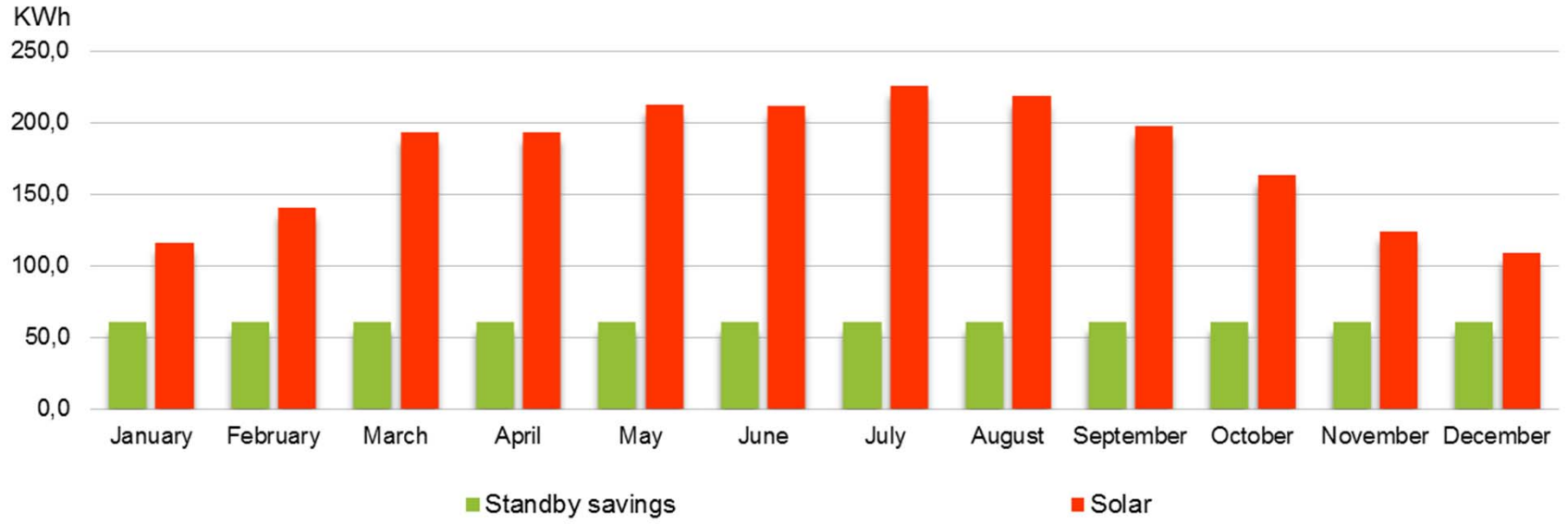
Standby in the first Passive House in Portugal Results



The standby mitigation contributes to reduce even further the energy demand of the building, specially if it is a Passive House.

Standby in the first Passive House in Portugal Results

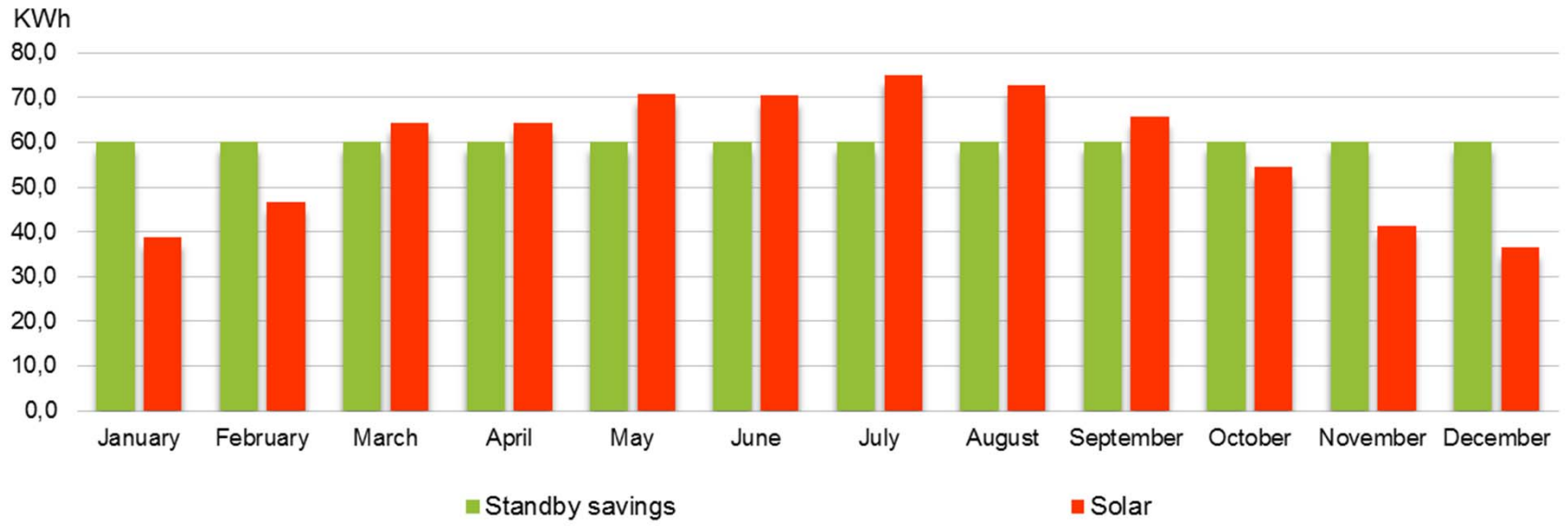
The **standby mitigation** in the first Passive House in Portugal induces **716,7** kWh of annual electricity **savings**, which is equivalent to **34 %** of **total electricity produced** from the **6 PV panels**.



source: PVGIS photovoltaic software

Standby in the first Passive House in Portugal Results

The **standby savings** of **716,7** kWh/a is **equivalent to 103 %** of **total electricity produced** from **2 PV panels**.



source: PVGIS photovoltaic software

Standby in the first Passive House in Portugal Results

The price of saved energy for the standby mitigation is estimated in **0,025 €/kWh**.

The price of saved energy for the 2 photovoltaic panels is estimated in **0,131 €/kWh**.

Considering:

Total investment for the standby mitigation: 291€

2 photovoltaic panels installed: 1500 €

20 years period (in both situations)

2 % interest rate (in both situations)

No residual value after 20 years (in both situations)

No investment for maintenance (in both situations)

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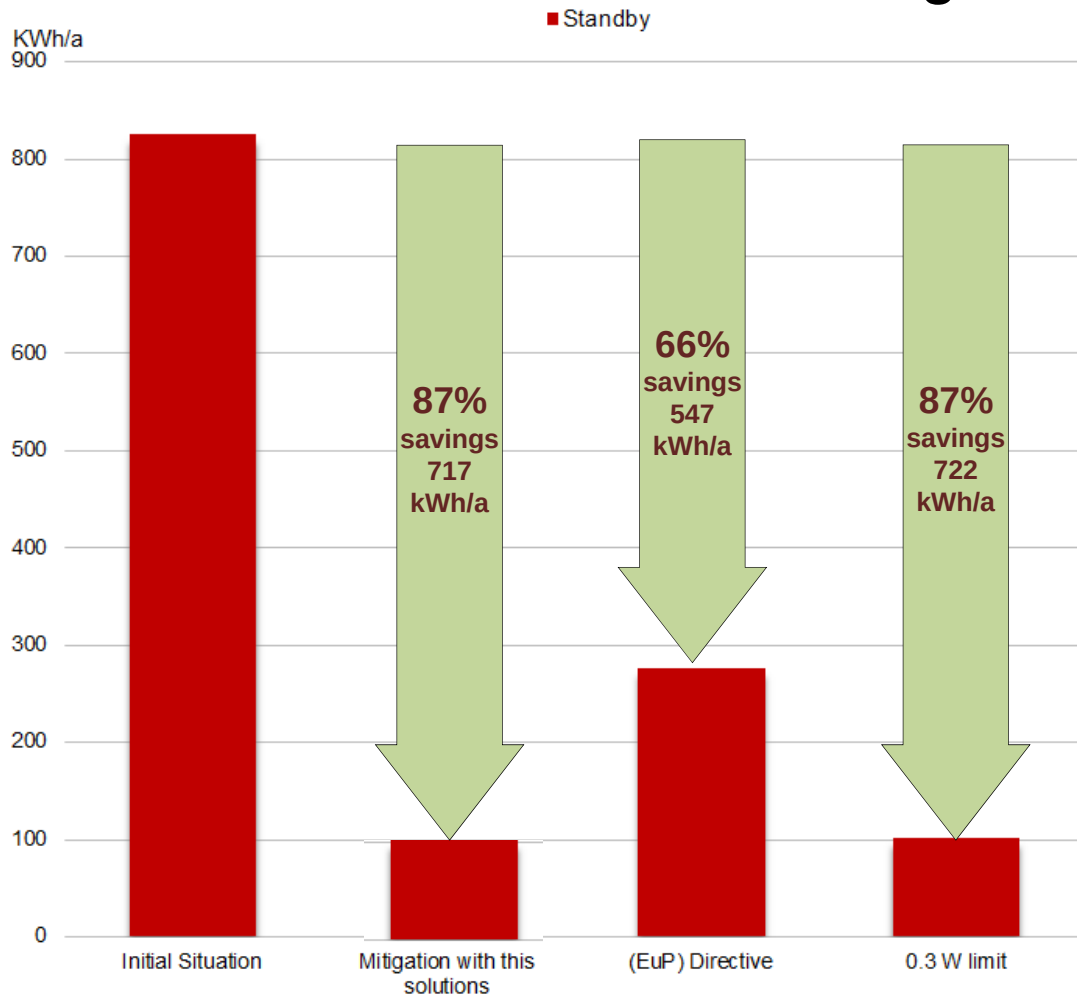
Standby in the first Passive House in Portugal

Results



	Initial Situation	Mitigation with this solutions	(EuP) Directive	0.3 W limit
Kwh/a	**823**	**107**	**276**	**101**
kWh/(m²a)	**3.69**	**0.48**	**1.24**	**0.45**
*PE demand =**53***	***7%***	***1%***	***2%***	***1%***

Conclusions

- The **standby consumption** already **represent 11%** of the total electricity consumption in buildings and **there is huge saving potential**.
- The **standby consumption** share **may be even bigger in Passive Houses**, due to the reduction of heating and cooling demand.

  …this can be even more relevant in Passive Houses in so called happy climates (with both lower heating and cooling demand).
- It is already **possible the mitigation** of the large share of standby consumption **in a cost-effective and easy way**.
- The **standby mitigation** can be **more interesting than** the **renewable** generation, both in small and large scale.

Future work

- **Labelling the standby consumption** of each device and equipment appears to be **essential to raise consumer awareness**.

- **PHPP** could answer this problem by **demanding inputs** regarding the **standby consumption** of the devices and equipment.

- **Establish a limit** for the standby consumption for the **component certification** for ventilation units, e.g. less then **0,3 W**.

Thank you!

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