

**POLITECNICO**  
**MILANO 1863**

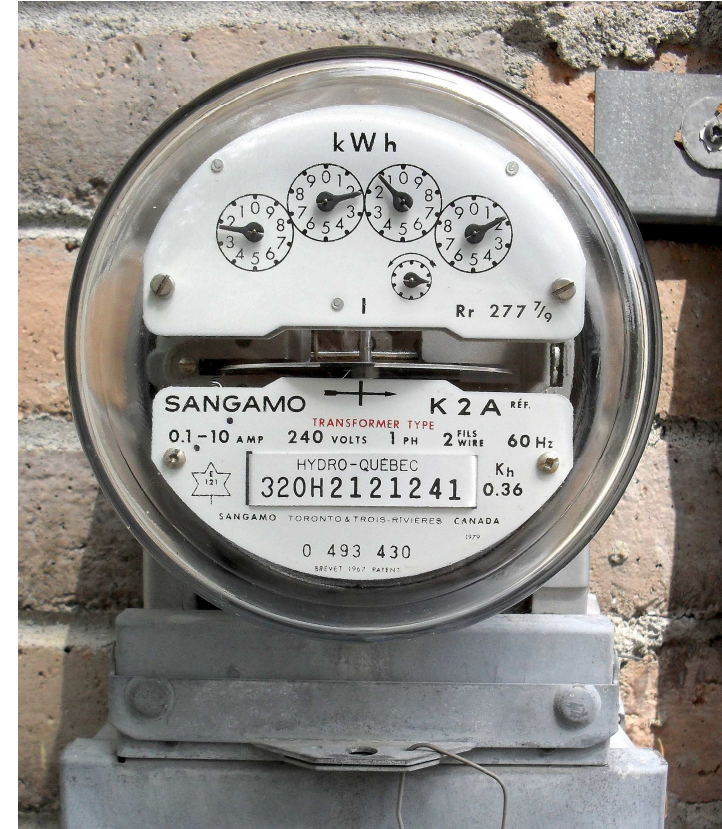
# Edifici ad alte prestazioni in clima mediterraneo

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# Cosa significa alta prestazione?

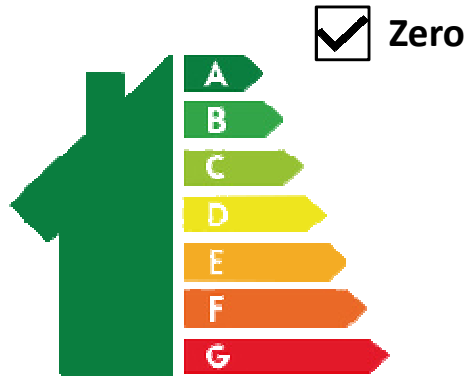


Comfort

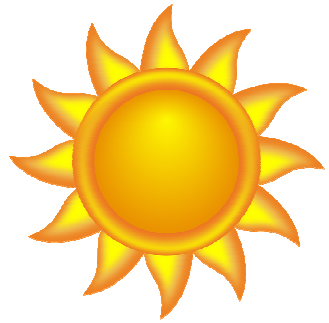


Risparmio energetico

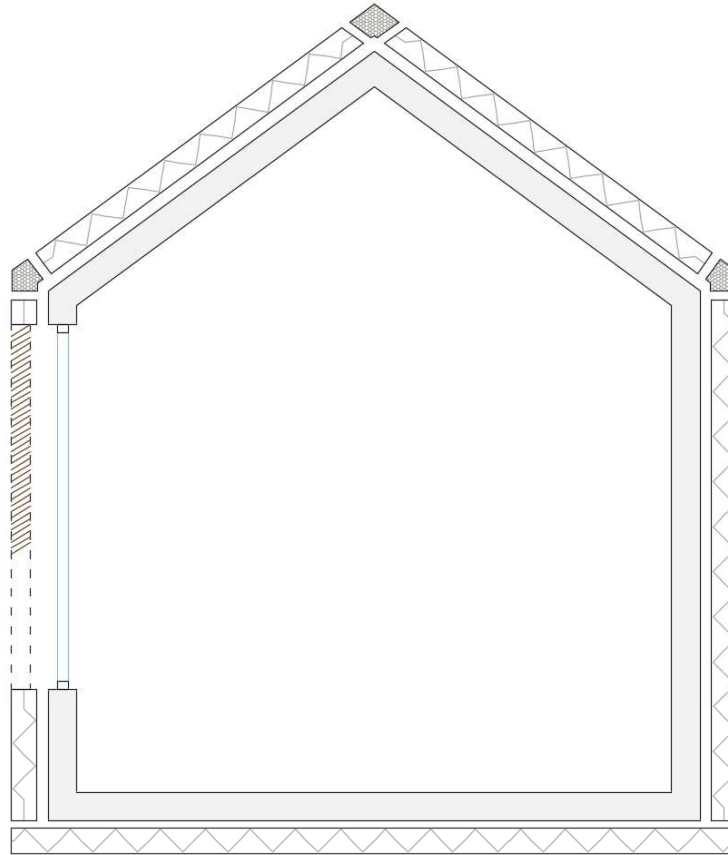
# Strumenti di progettazione e verifica?



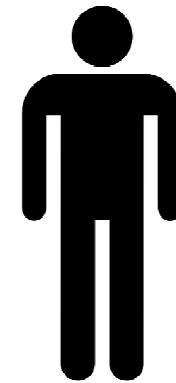
# Le forzanti e il sistema



Clima



Tecnologia

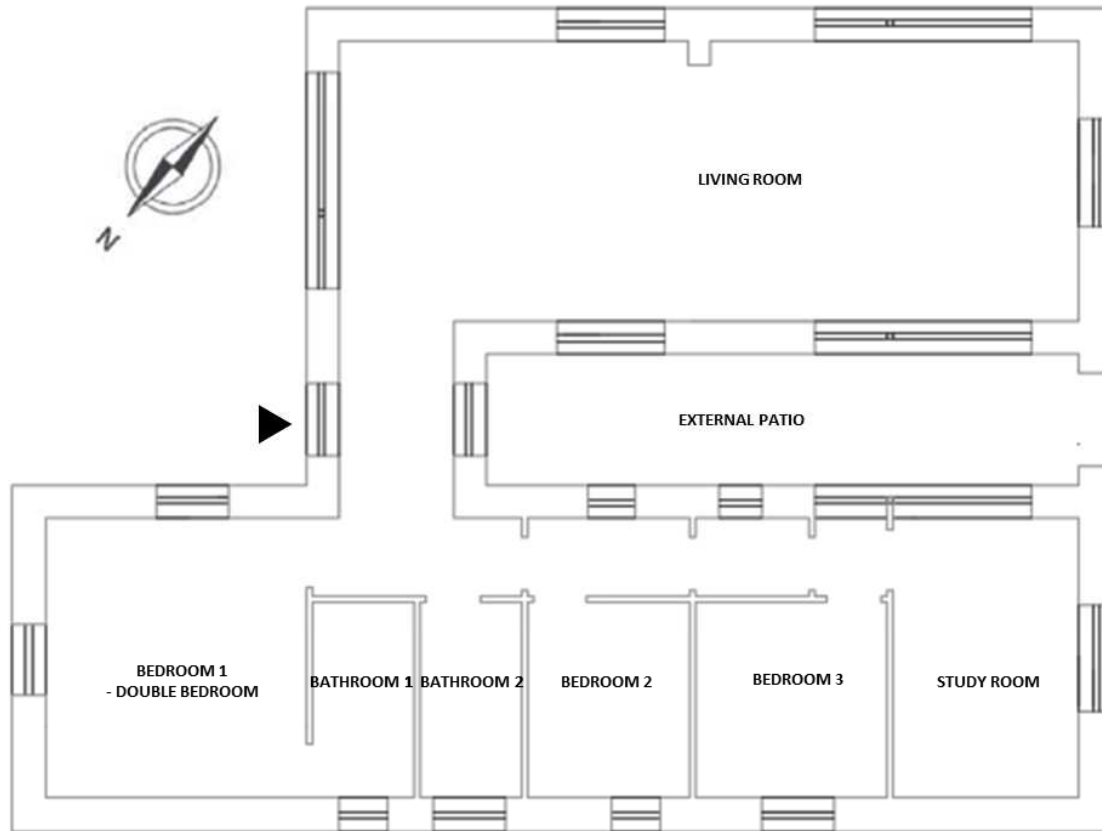


Utente

# Caso studio – Living Lab – Mascalucia (Catania)



# Caso studio – Living Lab – Mascalucia (Catania)



Mascalucia, Catania



Clima mediterraneo



Edificio monofamiliare



144 m<sup>2</sup> sup. calpestabile



Anno di costruzione 2011



Certificato Passive House



nZEB?

# Caso studio – Living Lab – Mascalucia (Catania)

Involucro

Tetto  
 $0.13 \text{ W/m}^2\text{K}$



Pavimento  
 $0.23 \text{ W/m}^2\text{K}$



Muri  
 $0.13 \text{ W/m}^2\text{K}$

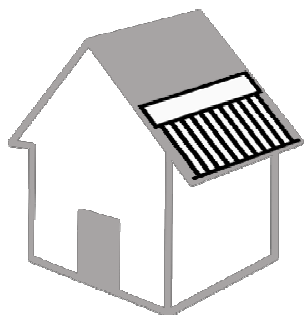


Finestre  
 $0.90-1.10 \text{ W/m}^2\text{K}$

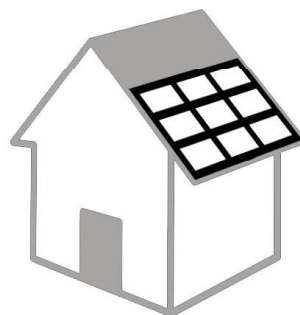


Rinnovabili

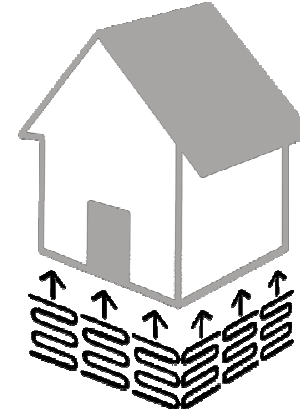
Solare termico



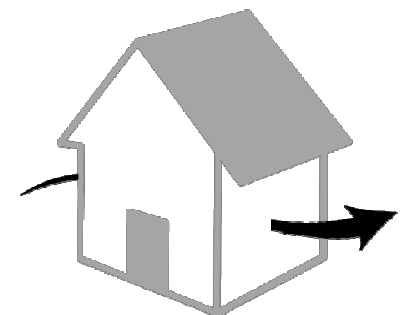
Fotovoltaico



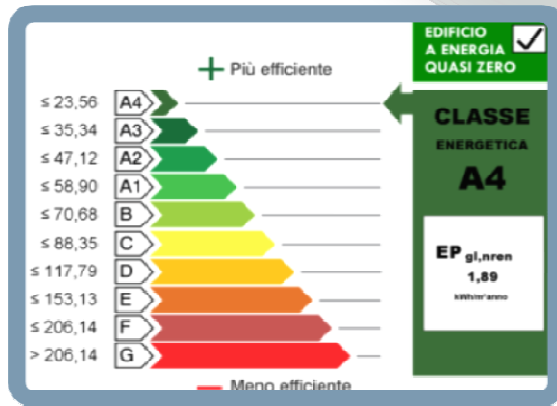
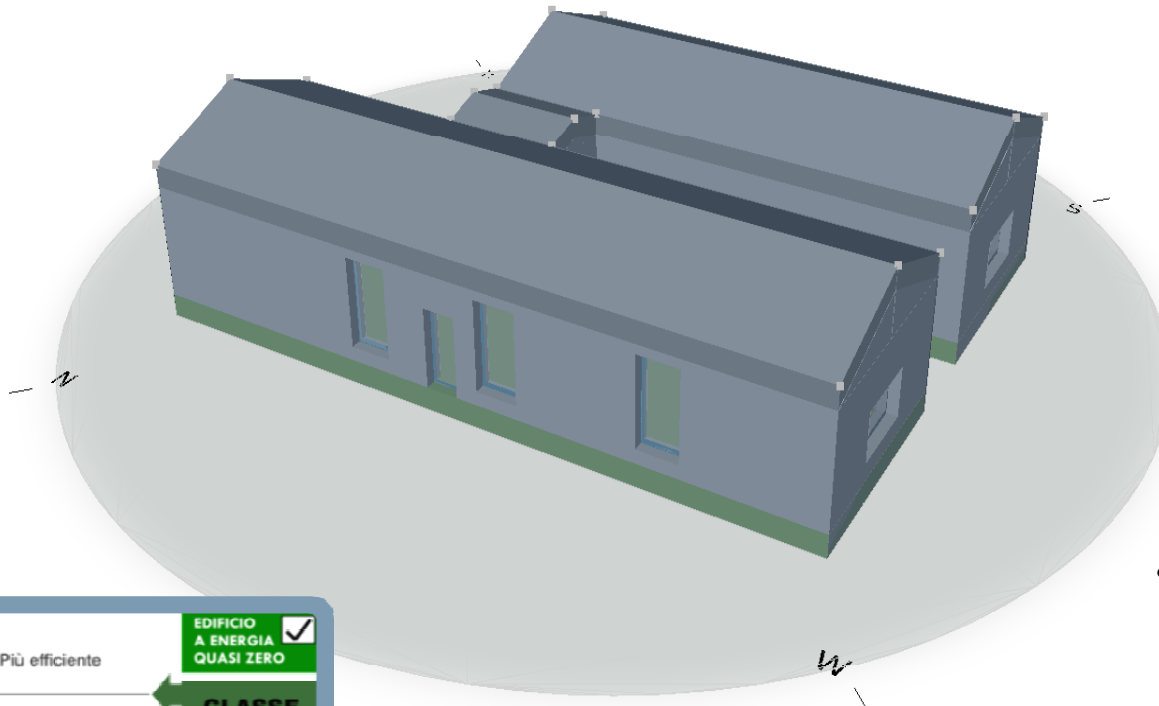
Scambiatore terreno



Ventilazione ibrida



# Verifica nZEB ex-post



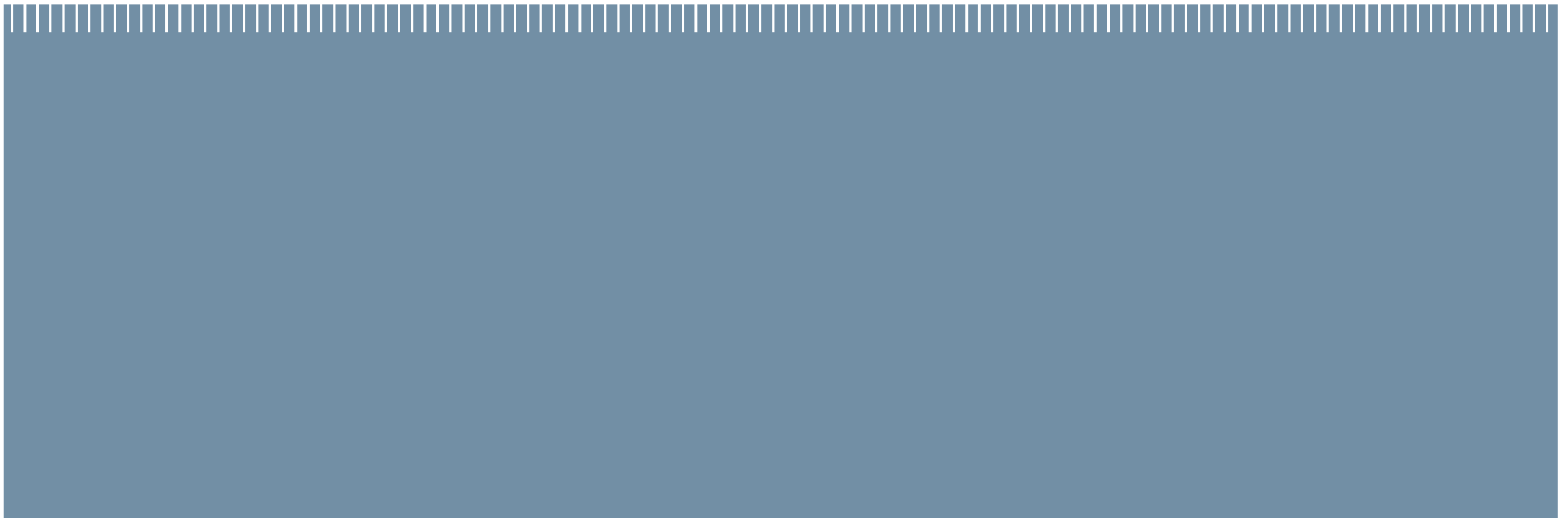
- Indici di prestazione energetica
$$EP_{H,nd} < EP_{H,nd,limite}$$
$$EP_{C,nd} < EP_{C,nd,limite}$$
$$EP_{gl,tot} < EP_{gl,tot,limite}$$
- Efficienze stagionali
$$\eta_H > \eta_{H,limite}$$
$$\eta_W > \eta_{W,limite}$$
$$\eta_C > \eta_{C,limite}$$
- Copertura termica
$$\% EP_{DHW} > 50 \%$$
$$\% (EP_C + EP_H + EP_{DHW}) > 50 \%$$



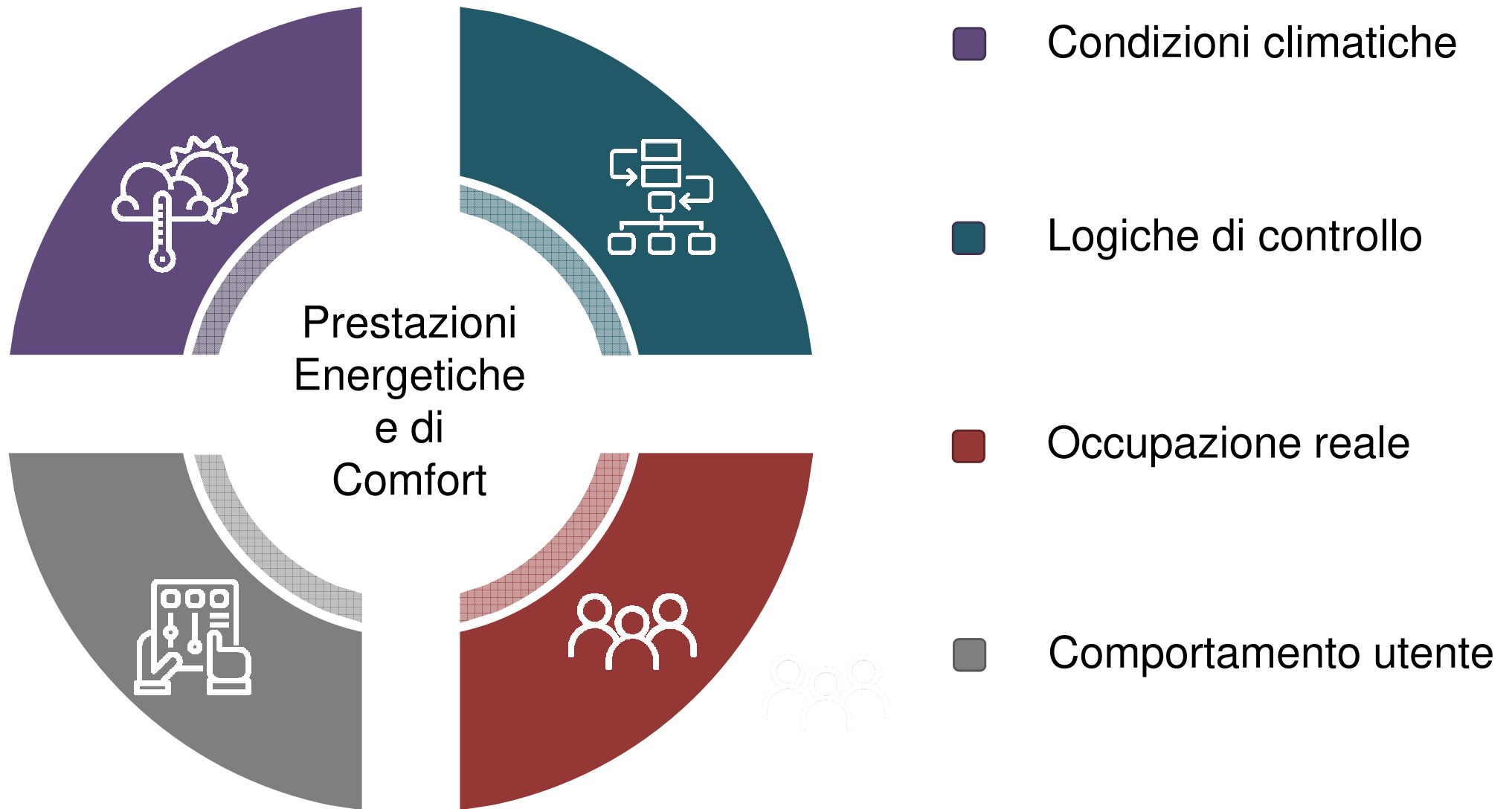
# Verifica nZEB ex-post

DM 26 June 2015			
Indicator	Numerical check	Unit	Description
$H'_T < H'_{T,max}$	0.19 < 0.55	[W/m <sup>2</sup> K]	Transmission heat transfer coefficient per unit of thermal envelope area
$\frac{A_{sol,est}}{A_{sup,utile}} < (A_{sol,est}/A_{sup,utile})_{max}$	0.0029 < 0.0030	[-]	Equivalent summer solar area per unit of useful floor area
$EP_{H,nd} < EP_{H,nd,limit}$ $EP_{C,nd} < EP_{C,nd,limit}$ $EP_{gl,tot} < EP_{gl,tot,limit}$	7.21 < 30.54 10.25 < 18.55 26.21 < 74.75	[kWh/m <sup>2</sup> y]	Energy need for heating Energy need for cooling Total global primary energy* (includes non-renewable energy and renewable energy)
$\eta_H > \eta_{H,limit}$ $\eta_W > \eta_{W,limit}$ $\eta_C > \eta_{C,limit}$	0.72 > 0.58 0.90 > 0.75 2.09 > 1.17	[-]	Average seasonal efficiency of the winter air conditioning system Average seasonal efficiency of the DHW system Average seasonal efficiency of the summer air conditioning system (includes moisture control)
*includes the following services/end-uses: winter air conditioning, DHW, ventilation, summer air conditioning, artificial lighting, transportation of people and things.			
Legislative Decree 3 March 2011			
Request		Numerical check	
cover 50% of primary energy for DHW through energy produced by RES (on-site)		share of renewable: 86.2 %	
cover 50% of primary energy for DHW, summer and winter air conditioning through energy produced by RES (on-site)		share of renewable: 93.1 %	
Power of the electrical renewable energy systems installed $P \geq (1 / K) * S$ [kW]		10.22 $\geq$ 2.88	

Quali sono le prestazioni in campo?



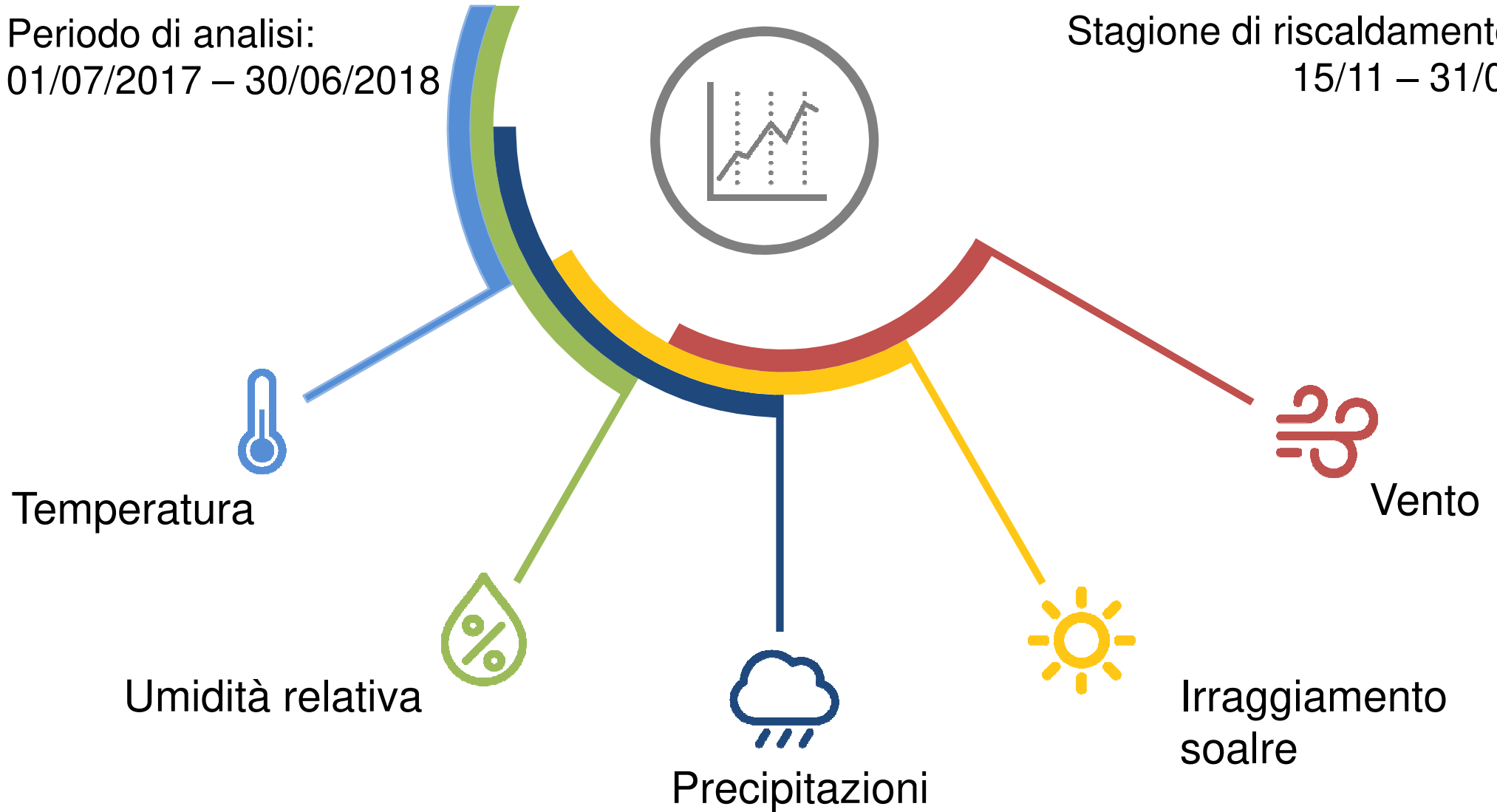
# Le forzanti in campo



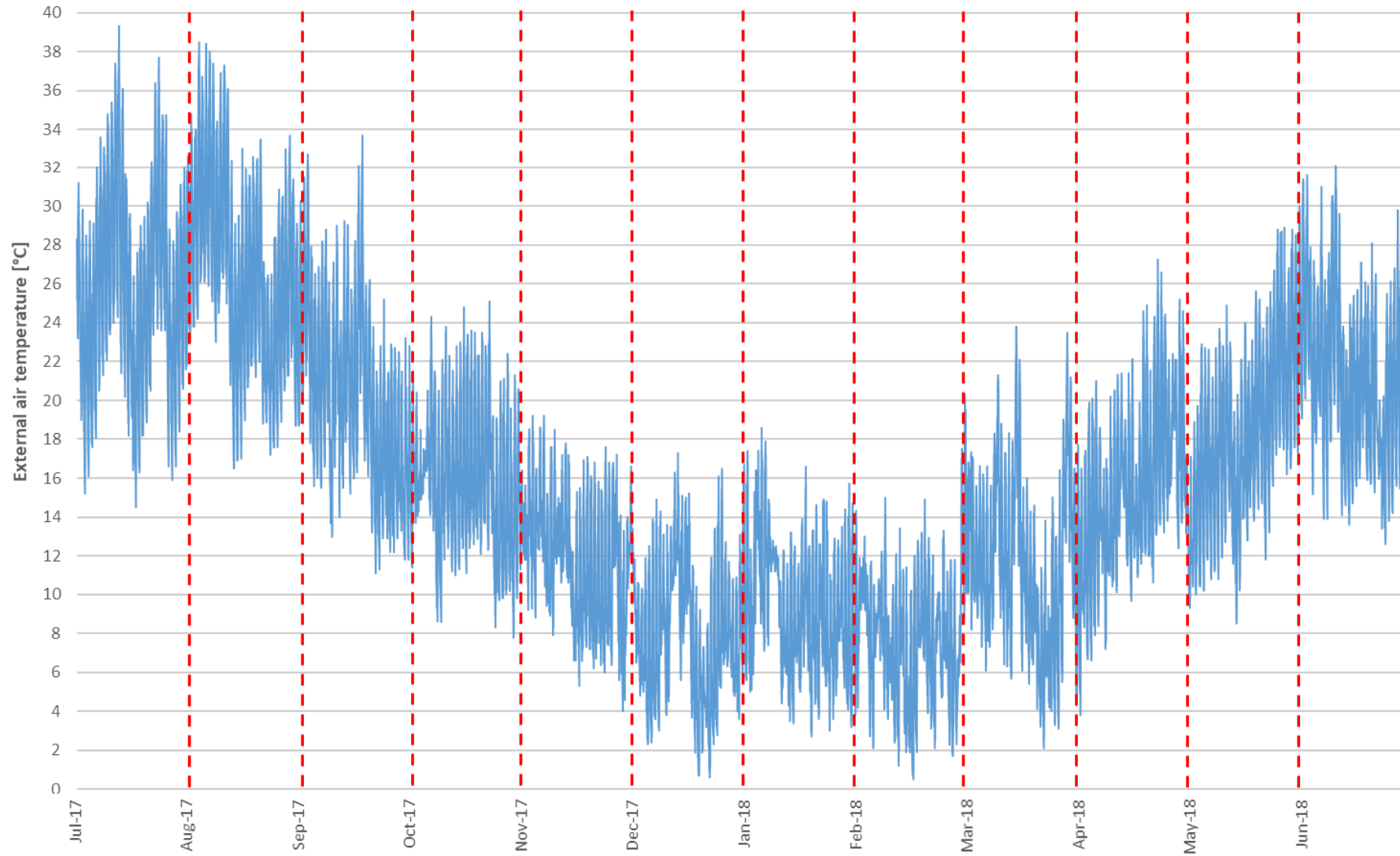
# Microclima locale

Periodo di analisi:  
01/07/2017 – 30/06/2018

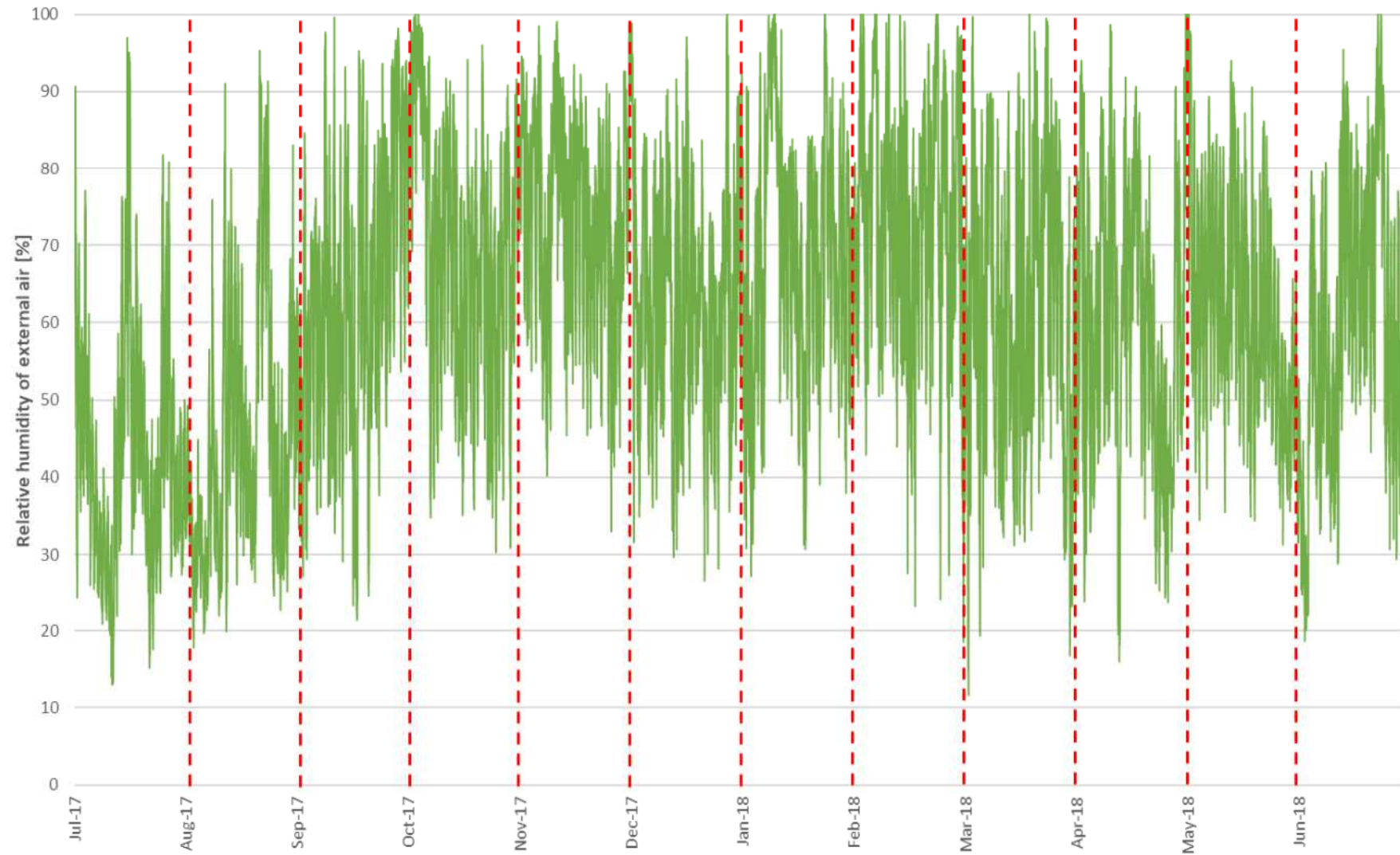
Stagione di riscaldamento:  
15/11 – 31/03



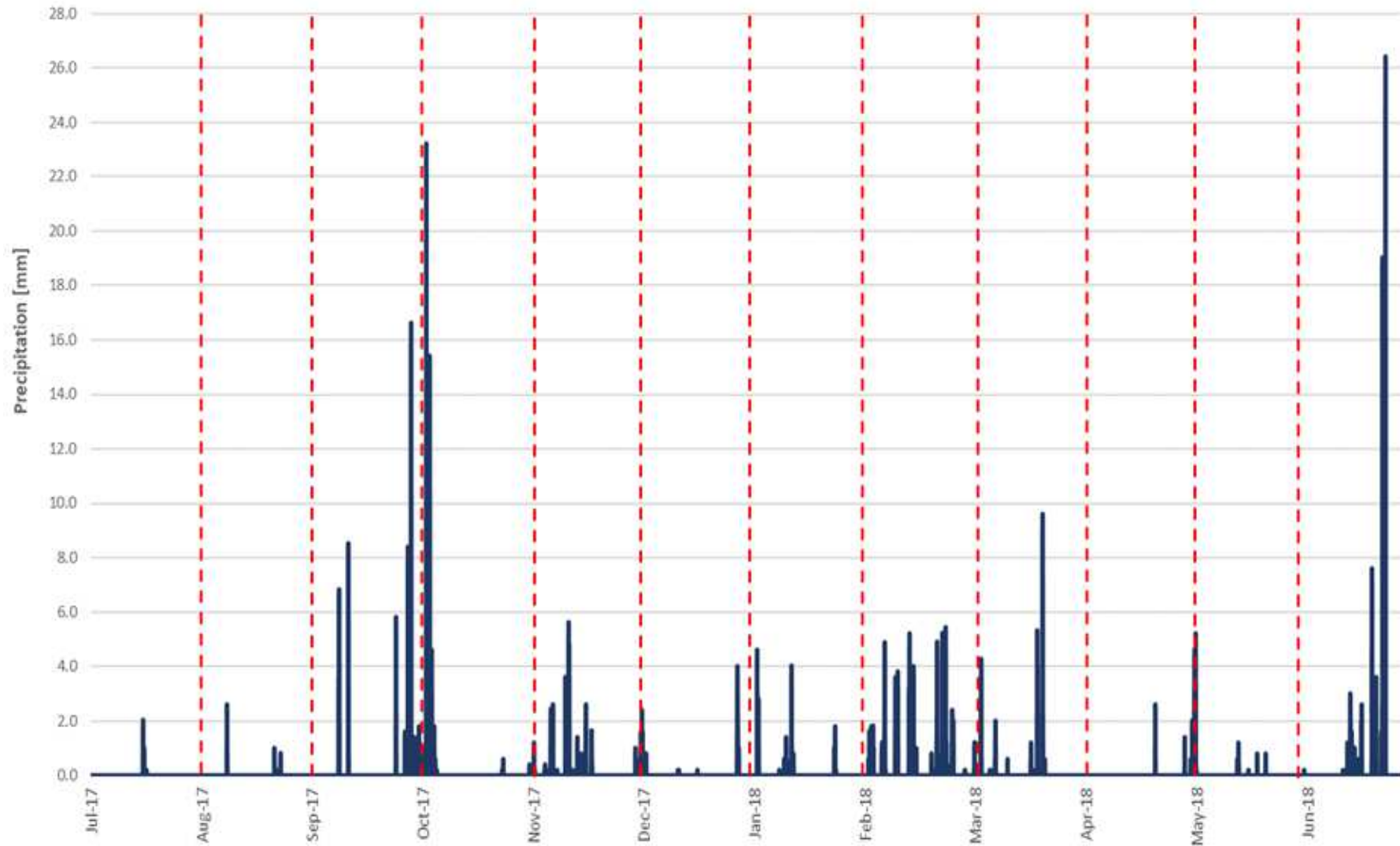
# Temperatura



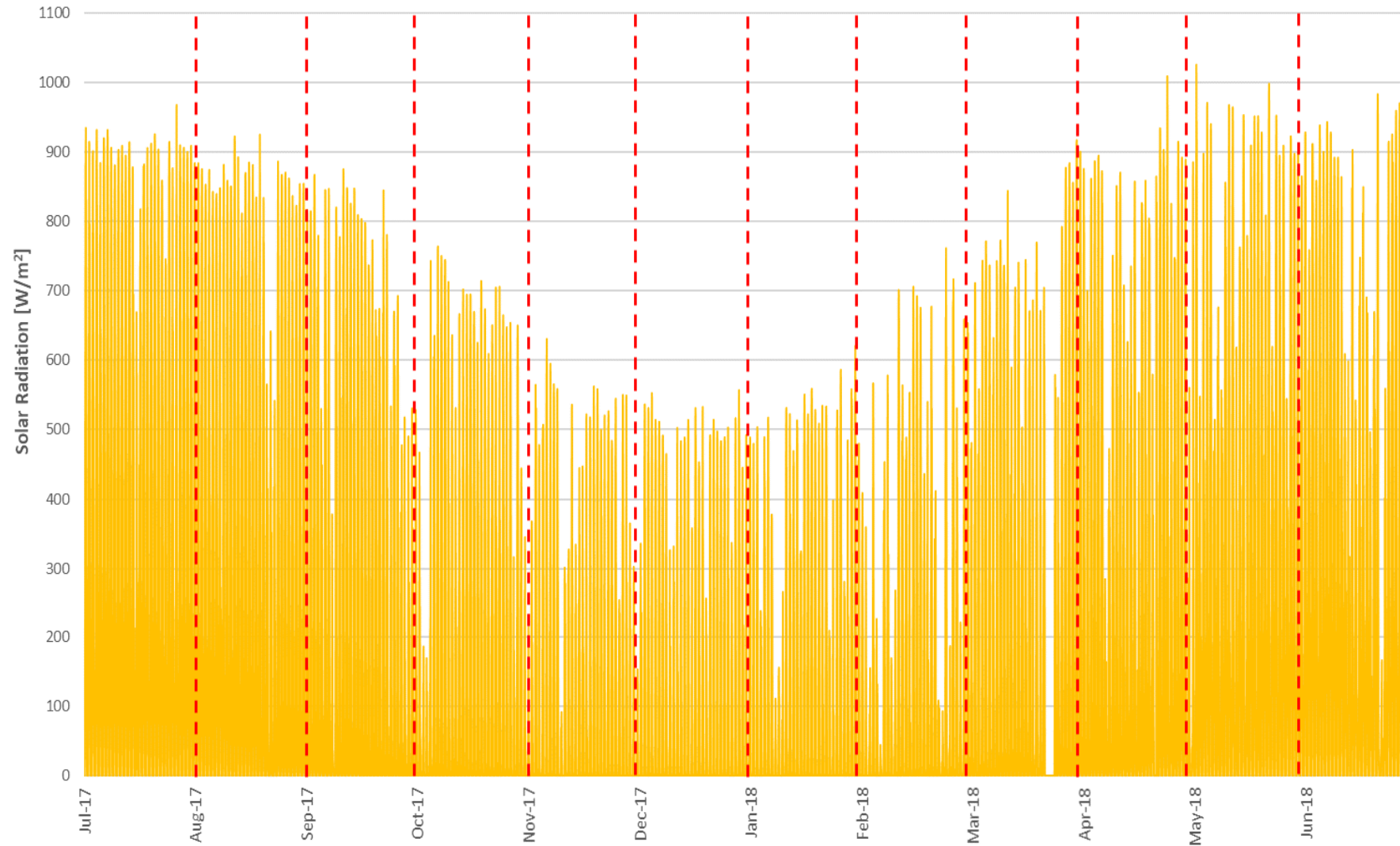
# Umidità relativa



# Precipitazioni

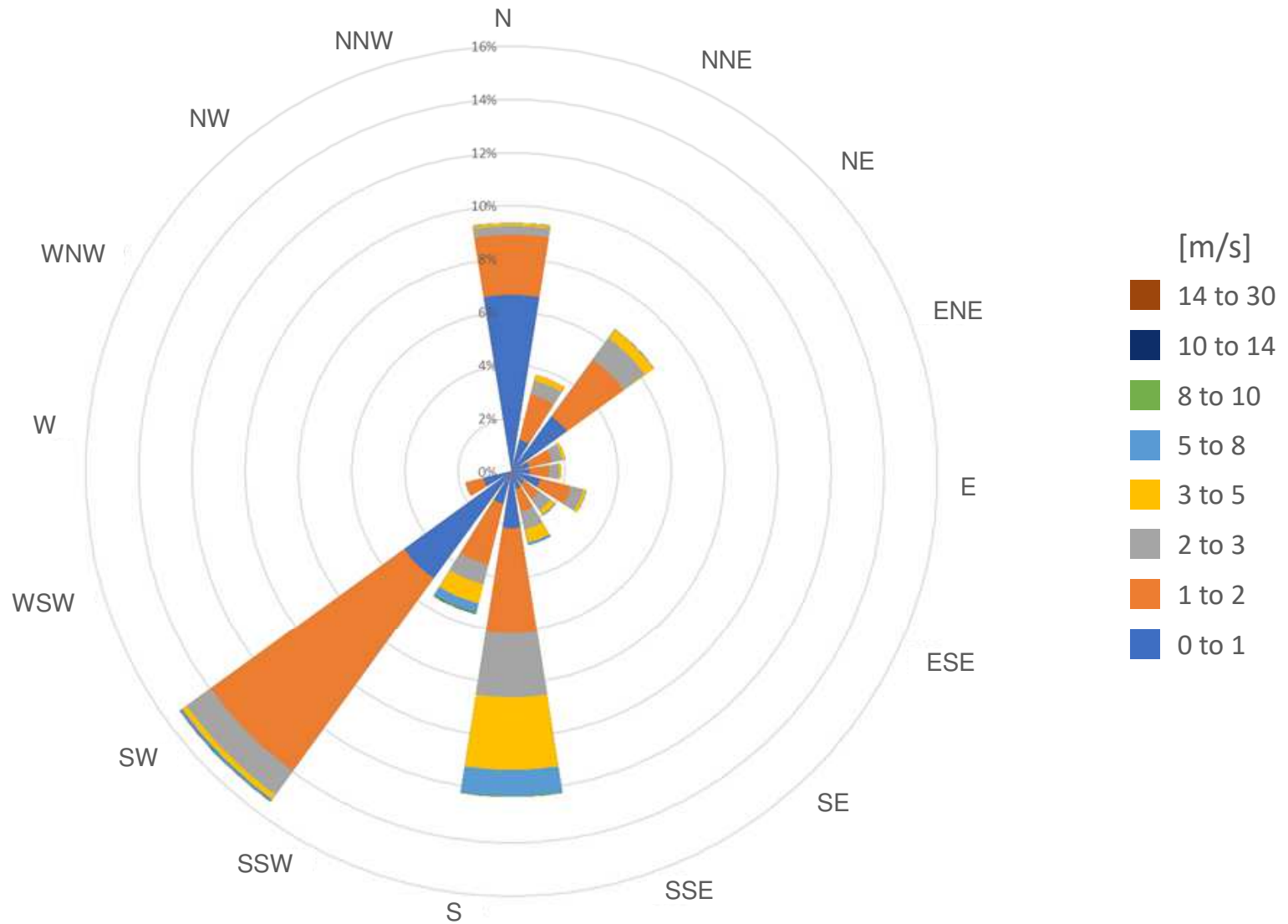


# Irraggiamento solare



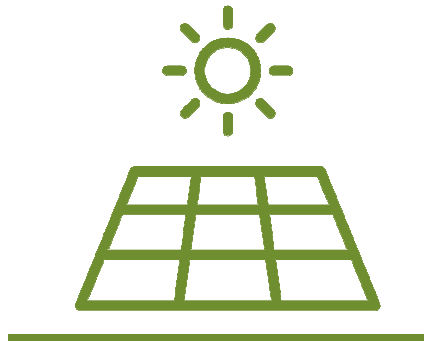


# Velocità e direzione vento



# Analisi energetica

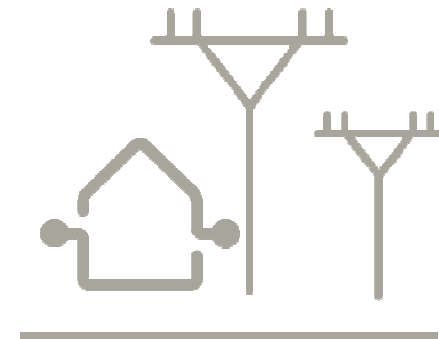
## Metodologia



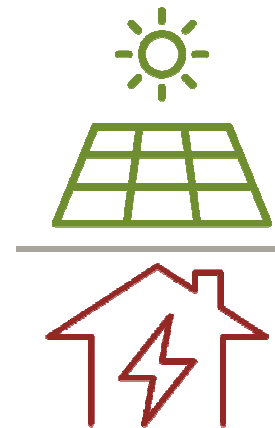
Energia elettrica  
da PV



Uso energetico  
totale



Interazione con la  
rete



Campionamento

- ✓ 5 minuti
- ✓ Orario
- ✓ Giornaliero

&

Bilancio energetico:

- ✓ Stagionale
- ✓ Annuale

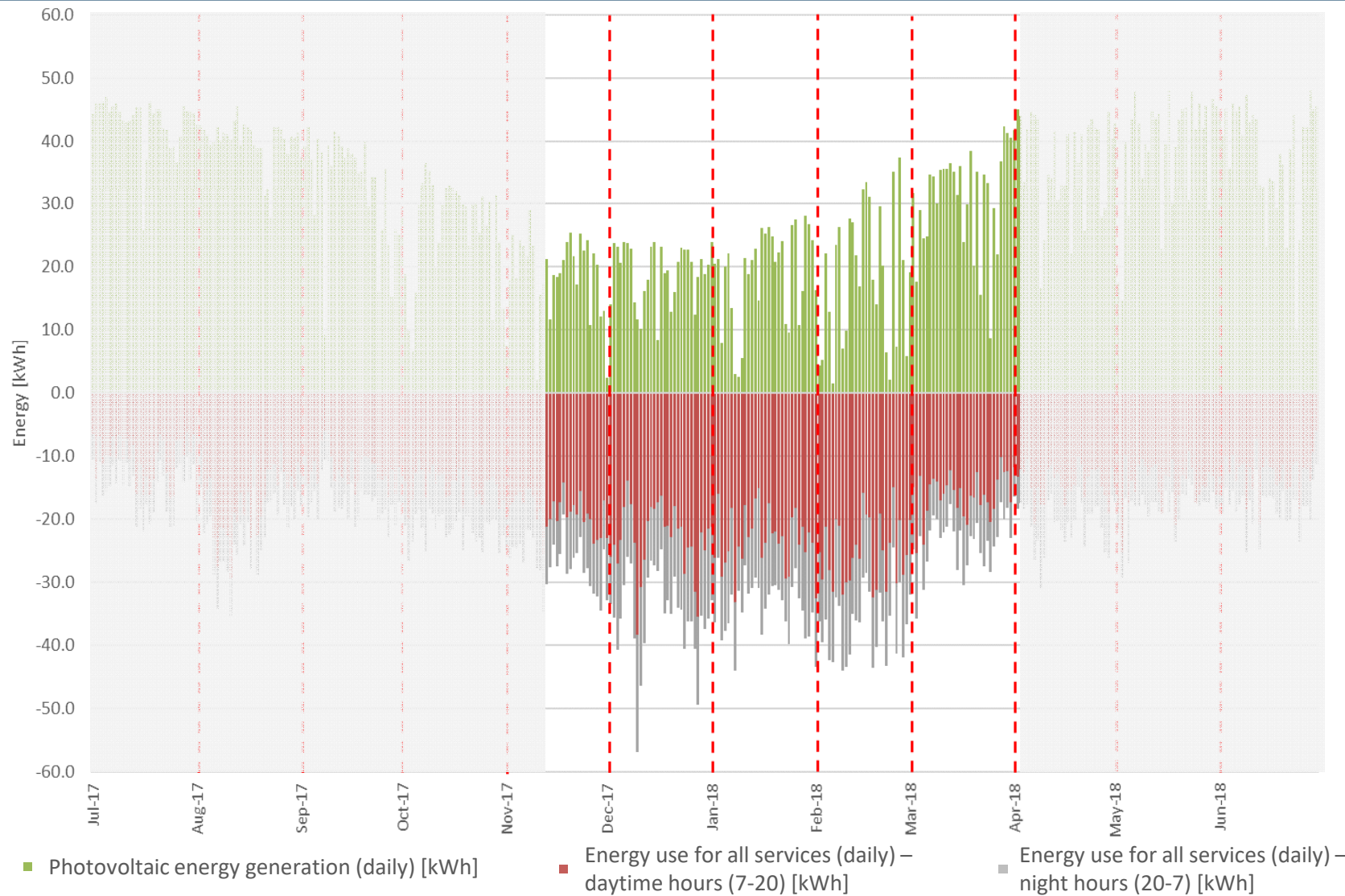
# Produzione e consumi giornalieri



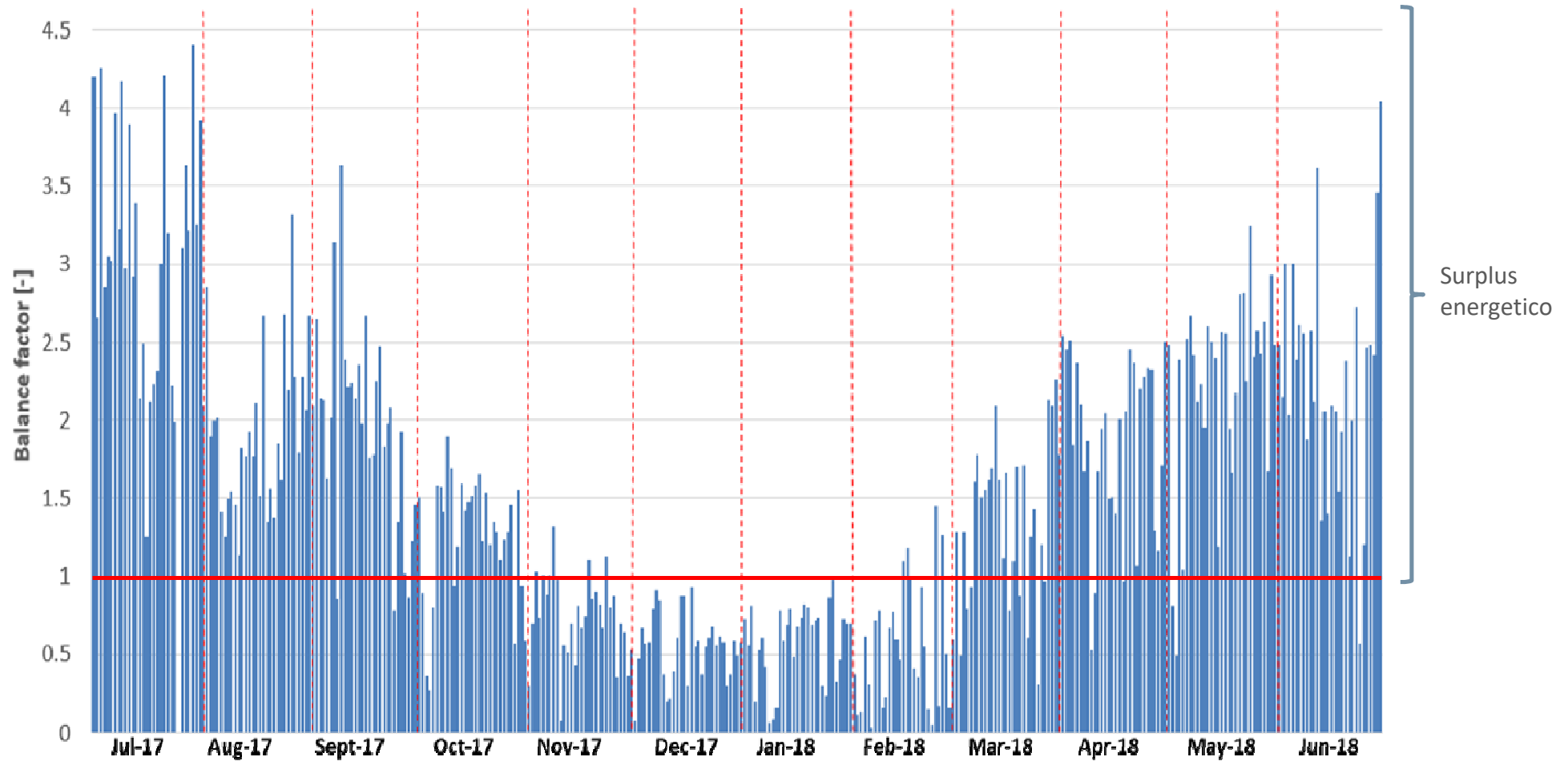
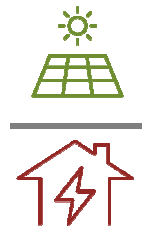
# Produzione e consumi giornalieri



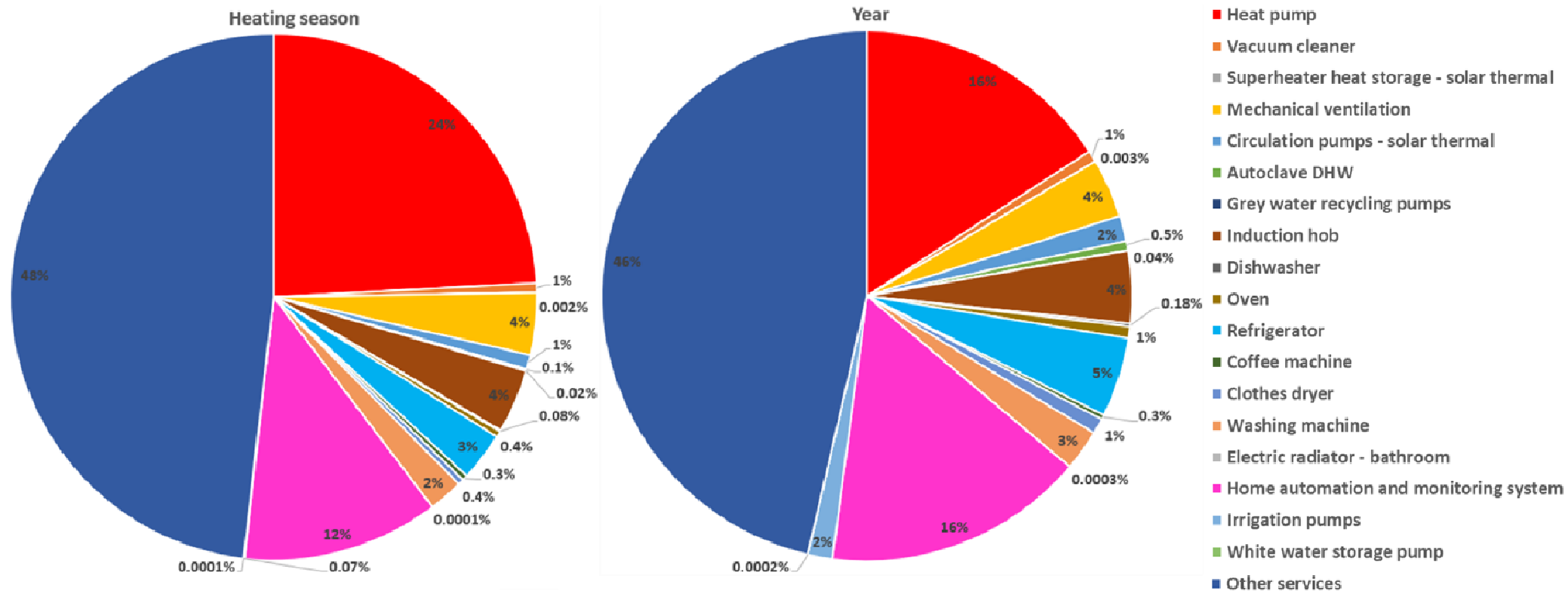
# Produzione e consumi giornalieri



# Interazione con la rete



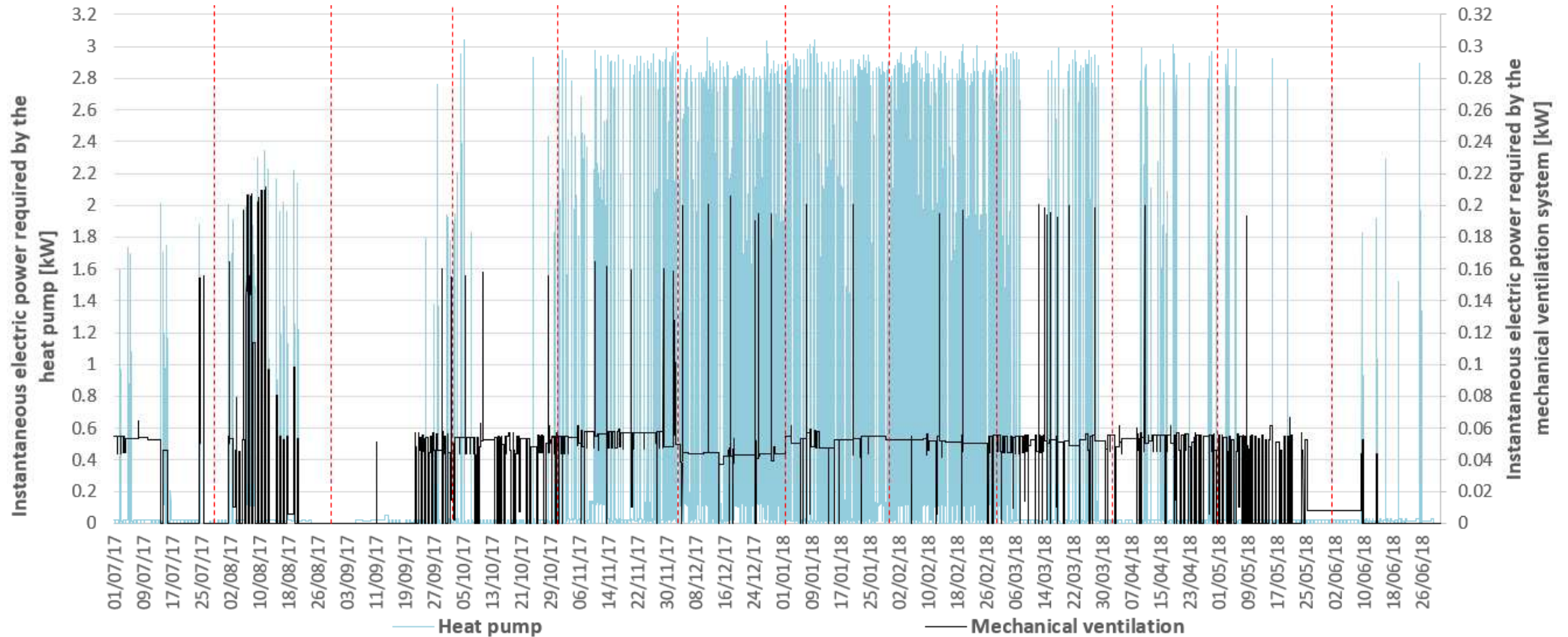
# Breakdown energetico



- Prese elettriche (46%)
- Pompa di calore (16%)
- Elettrodomestici (10%)
- CCTV e monitoraggio (16%)
- Altro (12%)

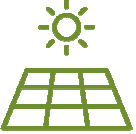


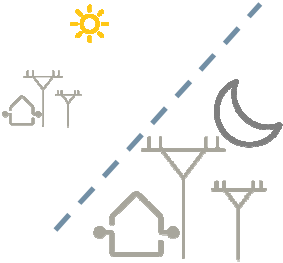

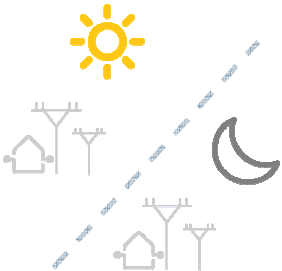






# Profili orari



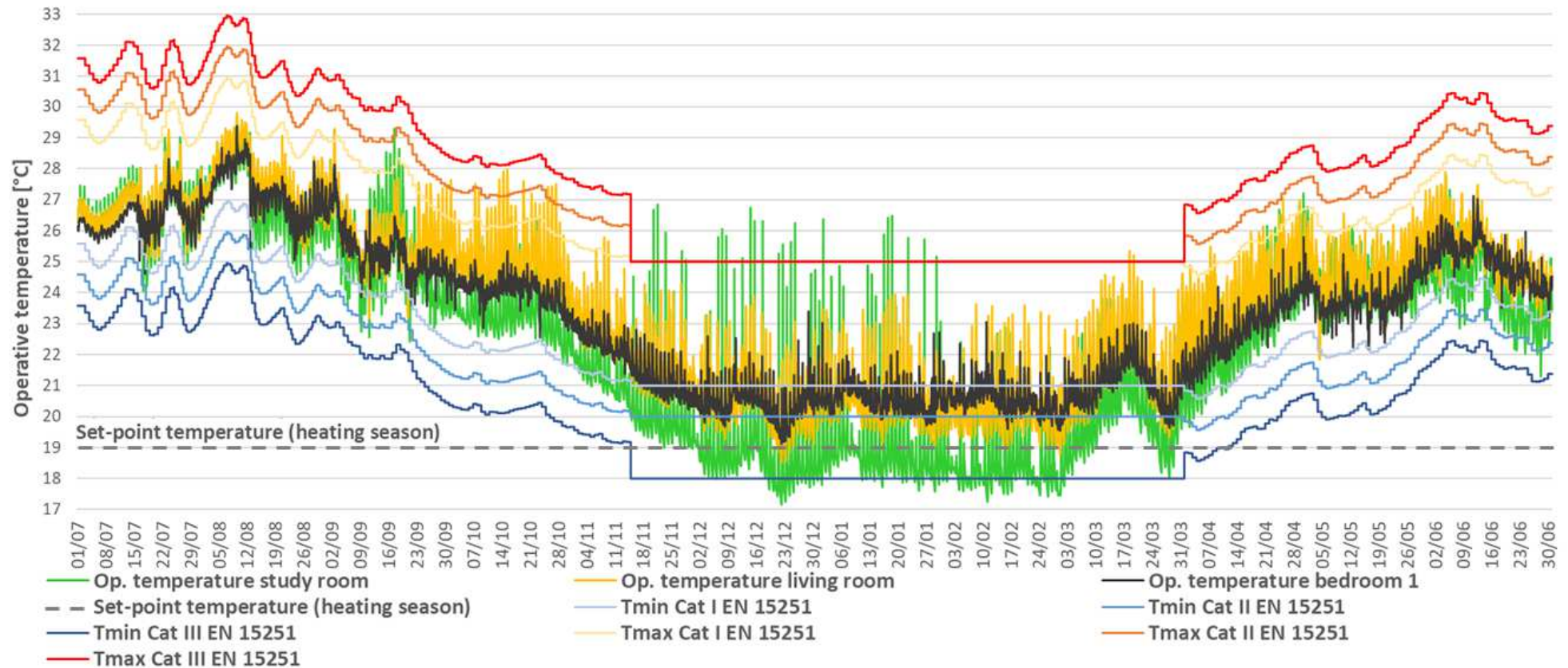


# Prestazioni energetiche in campo

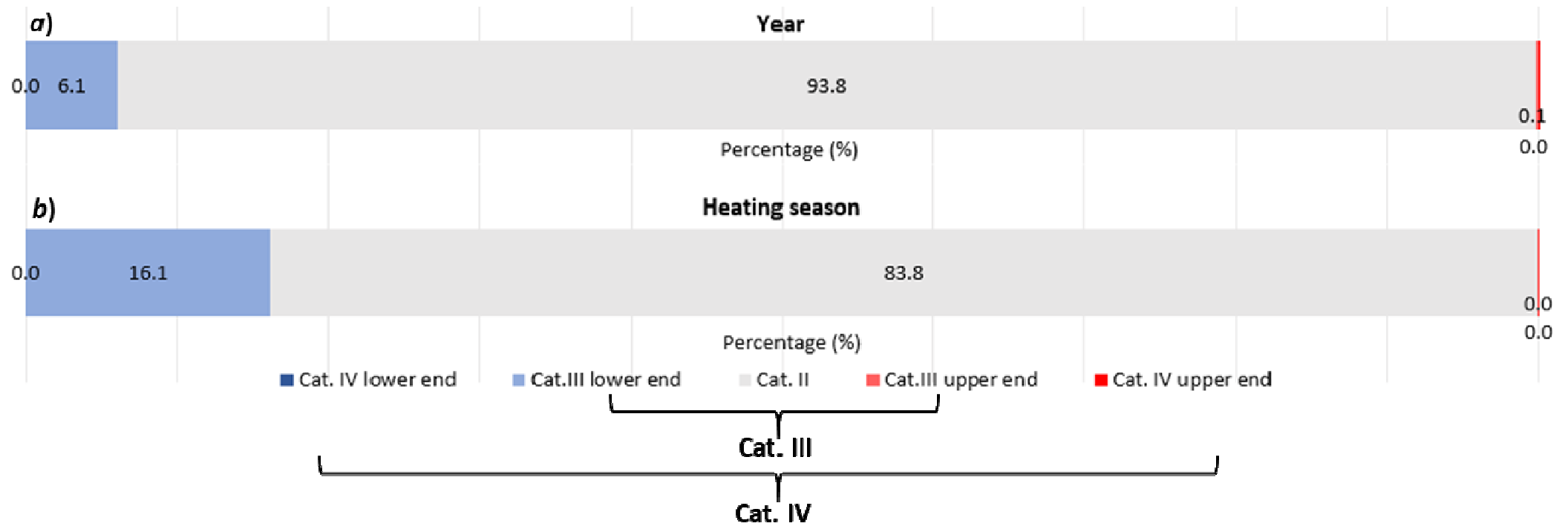
	<i>Raffrescamento (7.5 mesi)</i>	<i>Riscaldamento (4.5 mesi)</i>	<i>Anno</i>
	56.4 kWh/m <sup>2</sup>	20.4 kWh/m <sup>2</sup>	76.8 kWh/m <sup>2</sup> /year
	30.7 kWh/m <sup>2</sup>	30.2 kWh/m <sup>2</sup>	60.9 kWh/m <sup>2</sup> /year
			
			



# Analisi di comfort termico

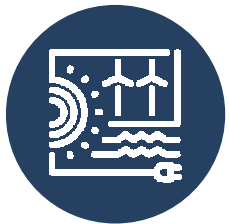


# Analisi di comfort termico



## **Sistemi di controllo (solare, vent., etc.) e comportamento dell'utente sono i 2 elementi determinanti delle prestazioni in campo!**

Sono risultate efficaci le seguenti strategie passive



- Sfruttamento radiazione solare
- Ventilazione notturna
- Sfruttamento inerzia termica del suolo

Valore aggiunto del Living Lab



- Indici di benchmark
- Indicazioni sul “peso” degli occupant
- Indicaizoni sul “peso” dei sistemi di controllo

Lavori futuri



- Modello termico scambiatore terreno
- Test logiche di controllo innovative e interazione con l'utente
- Dimensionamento accumulo giornaliero e/o stagionale

Grazie per l'attenzione

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