TIMEPAC
The new EPC for Europe

Analysis and validation of EN ISO 52016-1 and its Italian National Annex

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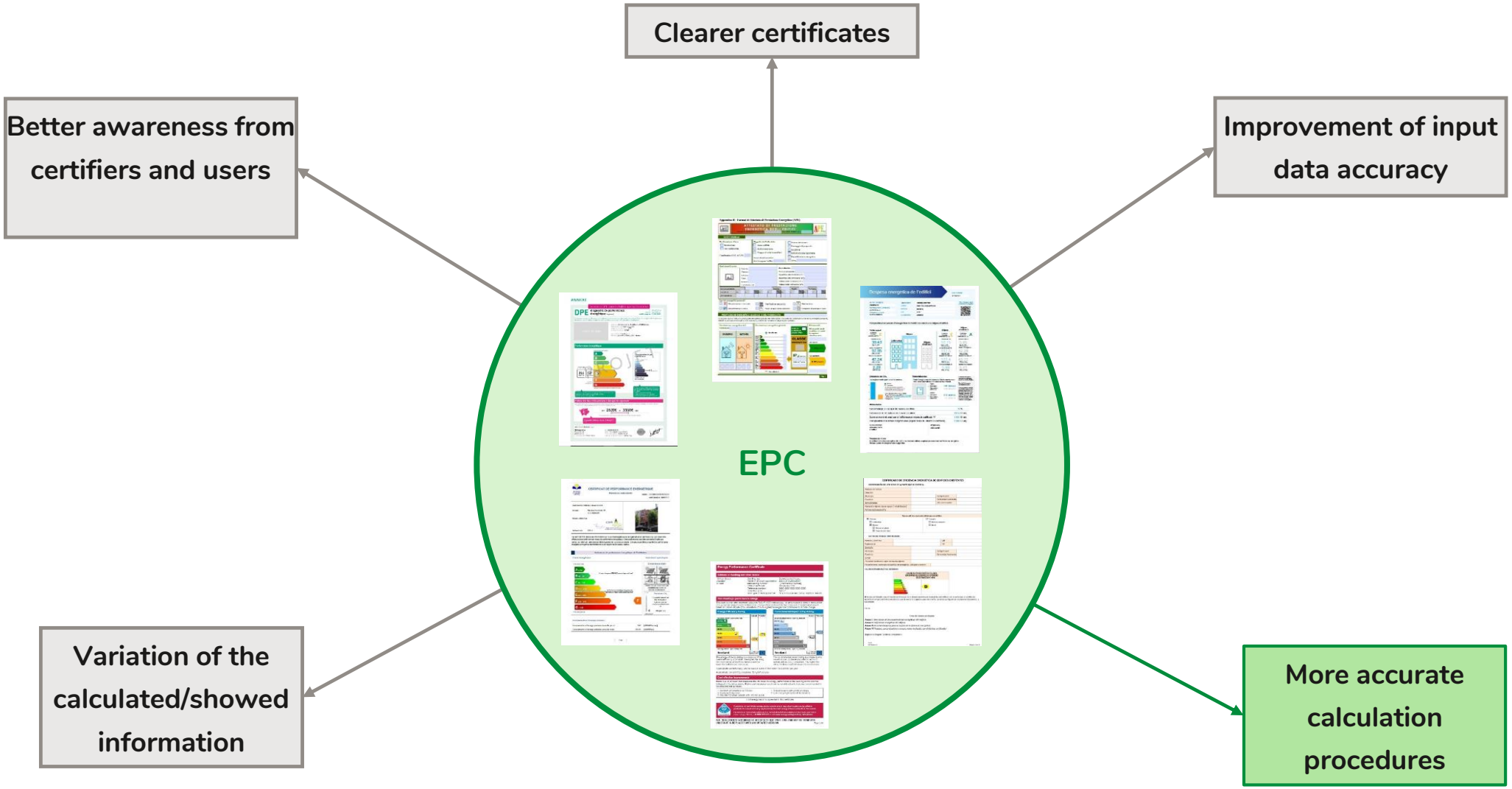
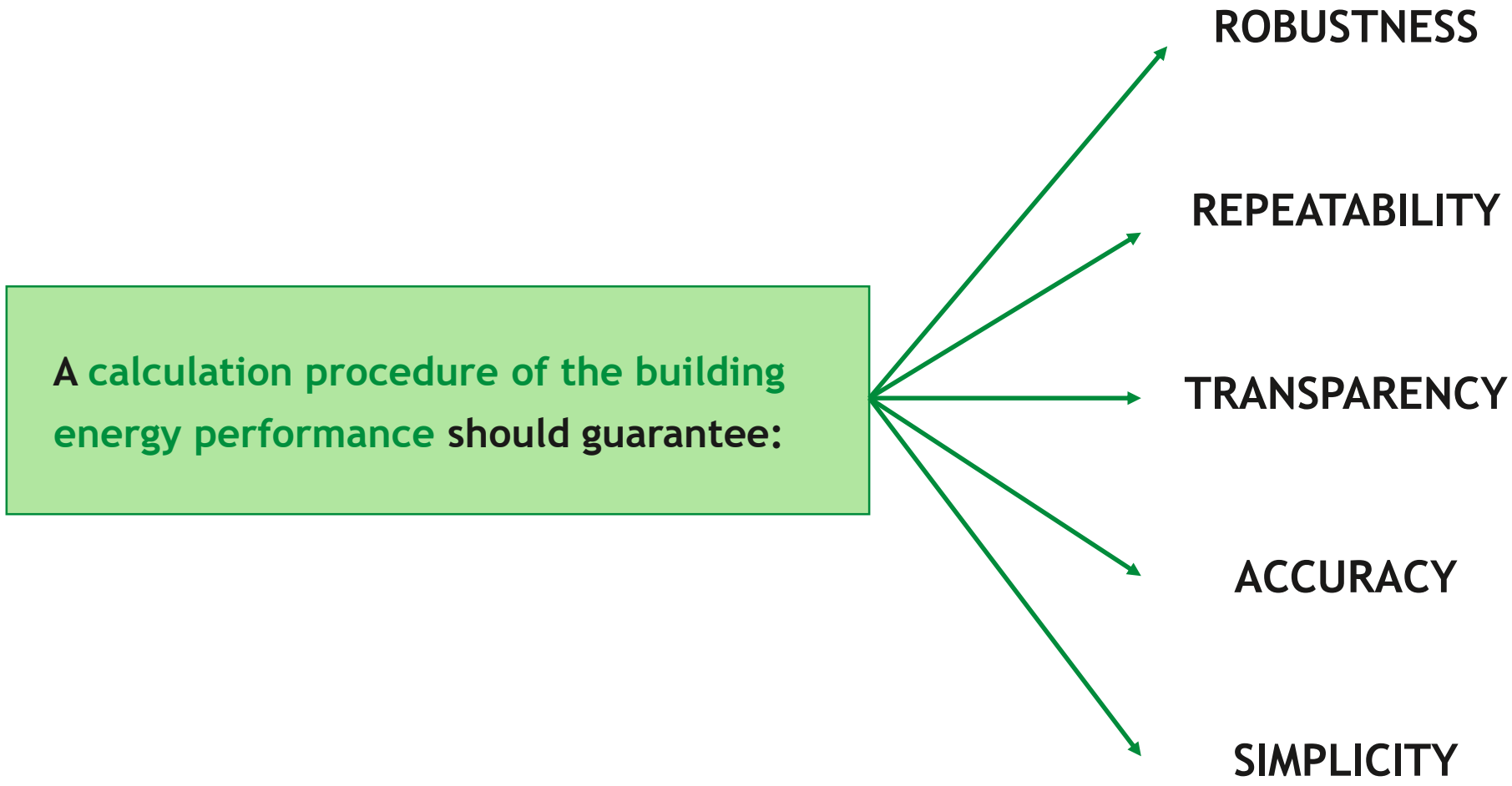
Possibility of improvement for EPC

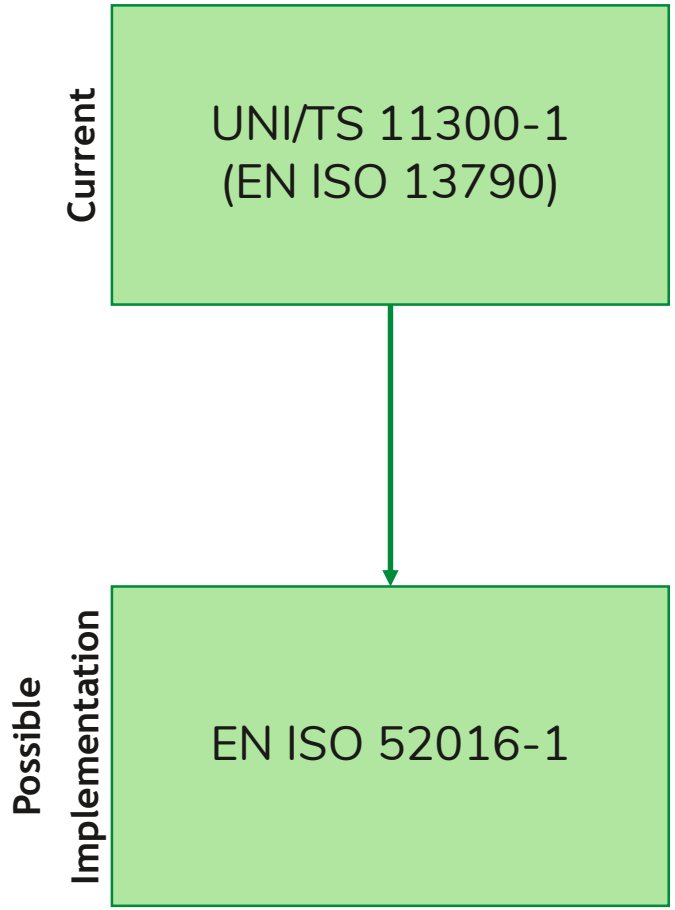


Calculation procedures requirements



Italian calculation procedures

Determination of the energy need for heating and cooling



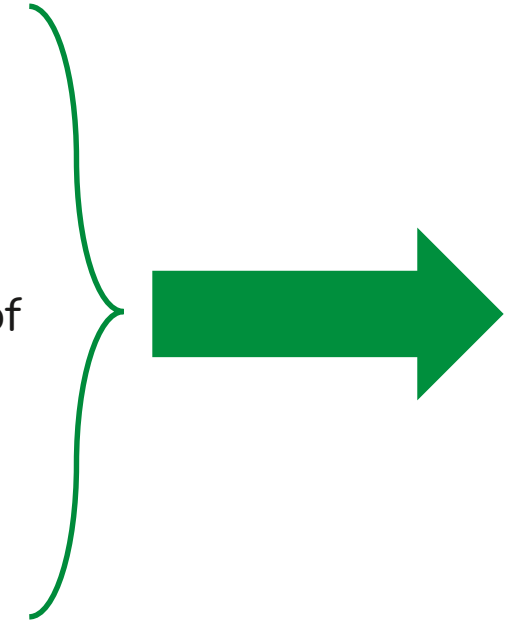
MODEL VARIATIONS AFFECTING ACCURACY

- Use of a simplified dynamic method instead of a quasi-steady state one
- Use of hourly timesteps in place of monthly ones
- Deployment of a R-C model for the discretisation of every building component in place of a single one used for the whole building fabric
- Different determination of the temperature of thermally unconditioned zones
- Variation in the determination of solar gains

Italian calculation procedures

Determination of the energy need for heating and cooling

- Are these improvements effective?
- What is the input sensitivity?
- What are the methods limits of applicability?
- Is this procedure simple enough?



VALIDATION PROCEDURES

Research framework

- The EPB-standards provide for National Annexes (NA) to enhance flexibility in the calculation procedure

- The NAs provide specific choices for the national or regional context in terms of modelling options, modelling parameters, and boundary conditions, where alternatives are considered in the standards

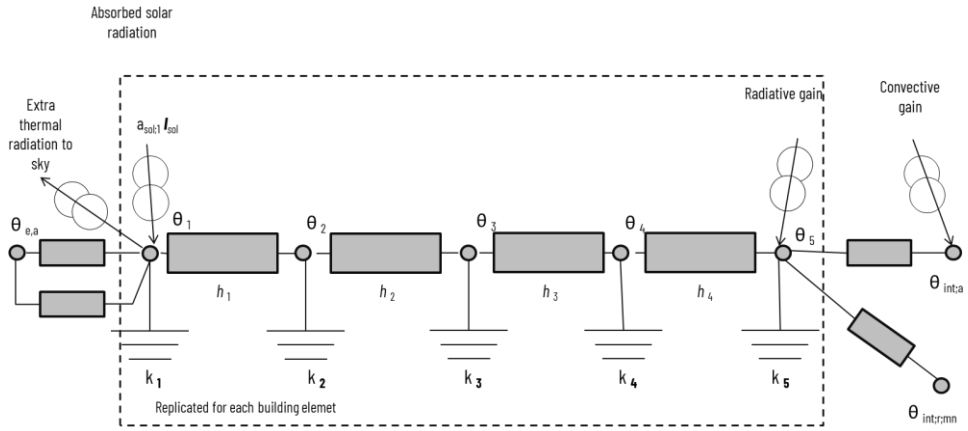
Research framework

- The EN ISO 52016-1 technical standard provides a simplified dynamic method for the building energy performance assessment
- The Italian NA to EN ISO 52016-1 (currently at the drafting stage) introduces improved options on different aspects of the building energy performance assessment
- It is crucial to broaden the existing knowledge of the improved modelling procedures introduced by the Italian NA
- The present research is intended to address the evaluation of the proposed procedures as to contribute to the enhancement of the Italian standardization activity, also for the improvement of EPC

Italian NA improvements to EN ISO 52016-1

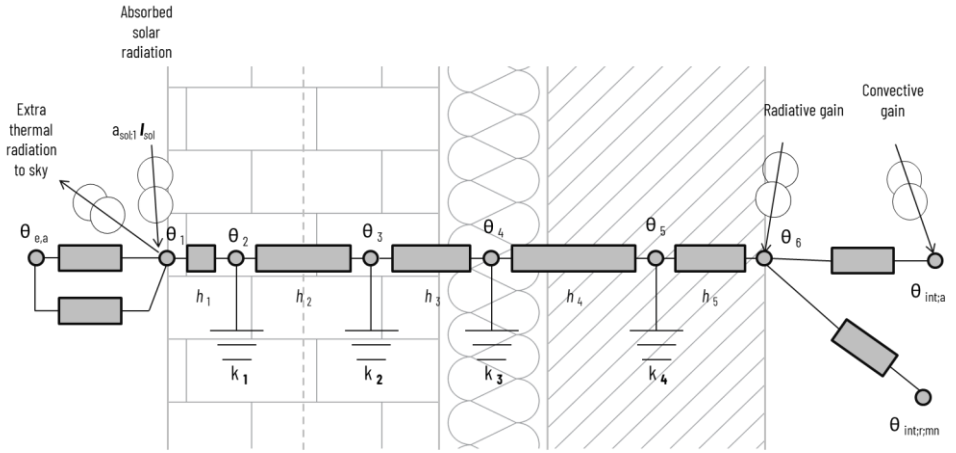
- **Heat conduction model** (NA_COND)

EN ISO 52016-1 approach



- Up to five R-C nodes, regardless of the specific characteristics of the component
- The total areal heat capacity is distributed over the R-C nodes, depending on the "mass distribution class"

Italian NA approach



- In line with the physical characteristics of the layers
- Number of R-C nodes per layer calculated through the comparison between the layer's and a reference Fourier number (at least one R-C node per layer)

Italian NA improvements to EN ISO 52016-1

- **Solar gains through windows** (NA_FW)

The total transmitted solar radiation is assumed to be all short wavelength radiation. A weighted time average value of the g-value is assumed over the simulation period by means of the F_W weighting factor.

$$g_{gl,t} = F_W \cdot g_{gl,n} \text{ [-]}$$

EN ISO 52016-1 approach

$F_W = 0{,}9$ [-]

- Time- and solar angle-independent window solar properties

Italian NA approach

$$F_W = \frac{F_{W,diff} \cdot I_{sol,diff,t} + F_{W,dir} \cdot I_{sol,dir,t} \cdot F_{sh,obst,t}}{I_{sol,diff,t} + I_{sol,dir,t} \cdot F_{sh,obst,t}} \text{ [-]}$$

where $F_{W,diff} = 0{,}8$ and $F_{W,dir}$ is calculated by means of the Karlson and Roos correlation (2000)

- Time- and solar angle-dependent window solar properties

Italian NA improvements to EN ISO 52016-1

- **Extra-thermal radiation to the sky** (NA_SKY)

The longwave radiation heat transfer includes the extra thermal radiation to sky (Φ_{sky}).

$$\Phi_{sky} = F_{sky} \cdot h_{re} \cdot \Delta\theta_{sky} \ [W/m^2]$$

where $\Delta\theta_{sky}$ is the difference between the outdoor air temperature and the apparent sky temperature θ_{sky}.

EN ISO 52016-1 approach

$$\theta_{sky} = \theta_{air} - 11 \ [K]$$

Italian NA approach

$$\theta_{sky} = 18 - 51{,}6 \cdot e^{-pve/1000} \ [K]$$

Methodology

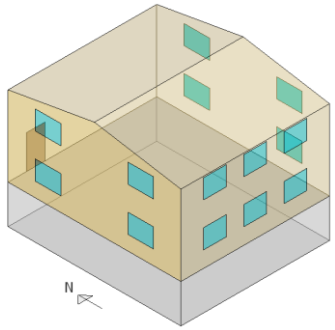
- Workflow phases

1. Full detailed dynamic simulation with EnergyPlus vs. standard EN ISO 52016-1 model

2. Improved Italian NA options vs. standard EN ISO 52016-1 model

Italian NA options implemented one-at-the-time to the standard EN ISO 52016-1 model, and all together

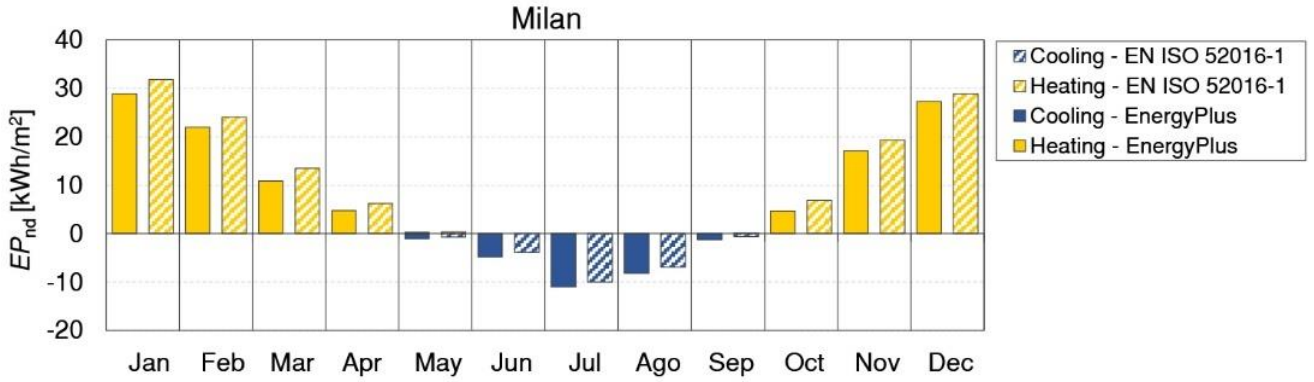
- Case study



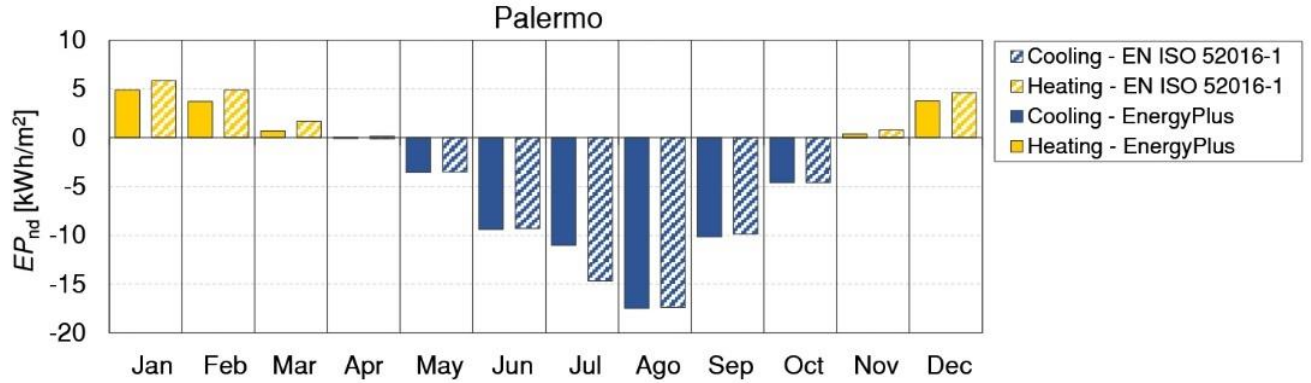
Parameter	Value
Conditioned floor area, A_f	198 m^2
Conditioned volume, V	537 m^3
Wall *U*-value, U_{wall}	0,8 W/m^2K
Wall areal heat capacity, k_{wall}	256 kJ/m^2K
Roof *U*-value, U_{roof}	1,1 W/m^2K
Roof areal heat capacity, k_{roof}	270 kJ/m^2K
Floor *U*-value, U_{floor}	0,9 W/m^2K
Floor areal heat capacity, k_{floor}	120 kJ/m^2K
Window *U*-value, U_{win}	2,8 W/m^2K
Window g-value, *g*	0,75

- Archetype of a two-storey single family house, representative of the existing single-family house building stock in Northern Italy, built between 1977 and 1990
- Characterized by two conditioned stories, and one unconditioned basement

Standard EN ISO 52016-1 model vs. EnergyPlus



Calculation model	$EP_{H,nd}$ (kWh/m²)	$EP_{C,nd}$ (kWh/m²)
EnergyPlus	115,9	27,4
EN ISO 52016-1	131,2 +13%	22,1 -19%



Calculation model	$EP_{H,nd}$ (kWh/m²)	$EP_{C,nd}$ (kWh/m²)
EnergyPlus	13,4	59,9
EN ISO 52016-1	17.9 +34%	59,5 -1%

Standard EN ISO 52016-1 model vs. EnergyPlus

Additional simulations (Milan)

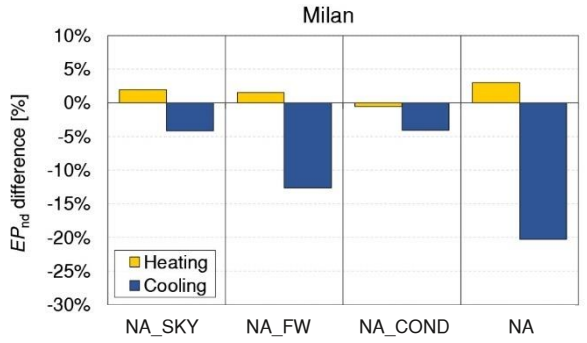
1. Constant convective heat transfer coefficients considered in EnergyPlus

Simulation	$EP_{H,nd}$ (kWh/m²)	$EP_{C,nd}$ (kWh/m²)
EnergyPlus (constant h_cs)	130,6	17,7
EN ISO 52016-1	131,2 +0,5%	22,1 +25%

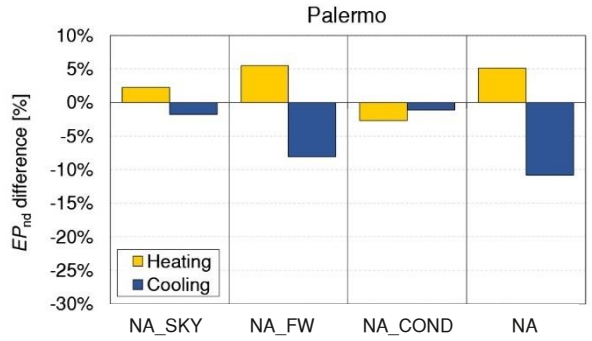
2. Removal of the contribution of incident solar radiation on the envelope components in both models

Simulation	$EP_{H,nd}$ (kWh/m²)	$EP_{C,nd}$ (kWh/m²)
EnergyPlus (no solar radiation)	188,4	0,0
EN ISO 52016-1 (no solar radiation)	183,2 -3%	0,1

Improved Italian NA options vs. standard EN ISO 52016-1 model



Energy need	EN ISO 52016-1	NA_SKY	NA_FW	NA_COND	NA
$EP_{H,nd}$ (kWh/m^2)	131,2	133,8 +1,9%	133,3 +1,5%	130,6 -0,5%	135,2 +3%
$EP_{C,nd}$ (kWh/m^2)	22,1	21,2 -4,2%	19,3 -12,6%	21,2 -4,1%	17,6 -20,3%



Energy need	EN ISO 52016-1	NA_SKY	NA_FW	NA_COND	NA
$EP_{H,nd}$ (kWh/m^2)	17,9	18,3 +2,3%	18,9 +5,5%	17,4 -2,7%	18,8 +5,1%
$EP_{C,nd}$ (kWh/m^2)	59,9	58,4 -1,8%	54,7 -8,1%	58,9 -1,1%	53,1 -10,8%

Symbol	Implemented Calculation Method
NA_SKY	Extra-thermal radiation to the sky
NA_FW	Solar gains through windows
NA_COND	Heat conduction model
NA	All the previous

Conclusions

- The use of solar angle- and time-dependent correction factors for the total energy solar transmittance of glazing proved to be the most sensitive modelling option. The other tested methods showed little – or almost negligible – variations

- The use of more detailed approaches should be evaluated to achieve the best trade-off between the accuracy and the simplicity of the assessment

- The opportunity to expand the Italian NA should be addressed to the aspects of the building energy performance assessment that proved to cause a decrease in the accuracy of the EN ISO 52016 1 hourly method

Thanks for your attention!

If you would like to have more information, please contact us:

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