MICAT

Multiple Impacts Calculation Tool

Empirical basis of Social Impacts Reduced or avoided excess cold weather mortality due to energy efficiency improvements in the residential building sector

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 101000132.

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Executive Summary

In Europe, in 2020, around 7 % of the EU population could not keep their houses adequately warm during the winter due to high heating costs and/or poor housing quality (Eurostat, 2022). Evidence shows that prolonged indoor cold has contributed to premature mortality, especially in the cold season (Braubach *et al.*, 2011). Energy efficiency measures applied in the existing residential housing can reduce indoor cold and its associated excess mortality.

The multiple impact (MI) indicator is reduced or avoided excess cold weather mortality due to energy efficiency improvements in the residential building sector. The first step for quantifying this indicator is to calculate the excess cold weather mortality (ECWD) in the EU, a given EU member country, or a city. A second step in modelling is to attribute ECWD to prolonged indoor cold exposure. However, no scientific studies have quantified the relationship between different types of energy retrofits in residential buildings and specific mortality reduction. Thus, assumptions are made between different retrofit types and ECWD reduction potential based on expert judgement (Mzavanadze, 2018).

Indoor cold generally affects the population experiencing energy poverty. Thus, the health benefits from energy efficiency investments will occur only if energy efficiency policies target this group. Accordingly, MICAT introduces a Policy Targetedness Factor to reflect energy renovation targeting households affected by energy poverty.

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Scope of MI indicator

Definition

The indicator measures reduced or avoided excess cold weather mortality (ECWD) due to energy efficiency improvements in the residential building sector.

Excess cold weather mortality (ECWD): excess mortality resulting from indoor cold during the cold season.

ECWD is a result of various factors, for example, "exposure to air pollution due to fossil-fuel-based heat supply in winter, indoor and outdoor cold, increase in winter-related infectious and bacterial epidemics as well as associated indoor crowdedness" (Eurowinter Group, 1997).

Overlaps with other MI indicators and potential risk of double-counting

Avoided premature mortality due to indoor cold may have an overlapping effect on public budgets and other macroeconomic variables, e.g., through changes in tax revenues, expenditure on public health services, etc. However, whether and to what extent these indicators are influenced by avoided premature mortality is not reliably quantifiable (e.g., dependent on the existence and setup of welfare state institutions in a country). This relationship is thus not taken into account in MICAT.

Relevance on EU, national and/or local level

Evidence shows that prolonged indoor cold has contributed to premature mortality, especially in the cold season (Braubach et al., 2011). In Europe, in 2020, around 7 % of the EU population could not keep their houses adequately warm during the winter due to high heating costs and/or poor housing quality (Eurostat, 2022). However, the share varies across different countries; for instance, it was more than 23% in Bulgarian but only 1.7% in Austria (ibid.).

Impact pathway figure

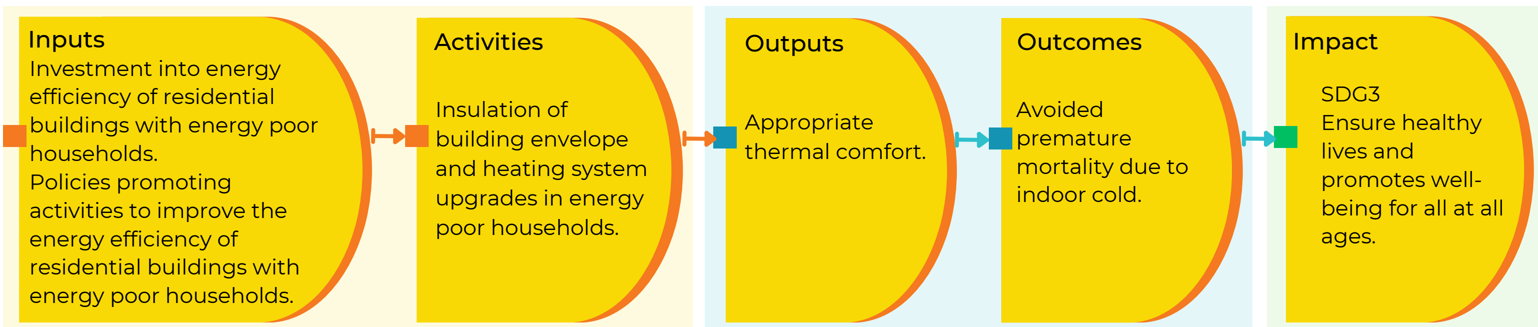

Figure 1 : Logic model (theory of change) for reduced or avoided excess cold weather mortality due to energy efficiency improvements in the residential building sector

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Quantification method

Description

The indicator is calculated by comparing the mortality cases during the cold weather period prior to and projected excess cold weather mortality after the implementation of energy efficiency measures.

The first modelling step is calculating excess cold weather mortality (ECWD). MICAT will adopt the estimates of ECWDs from the COMBI project funding from EU Horizon 2020, where a methodological upgrade in excess cold weather mortality was proposed in response to a recent academic critique (Mzavanadze 2018). A cold weather period includes at least 85% of a specific country's average annual heat degree days (HDD). At the city level, ECWD is assumed to be proportion to the share of the city population in the country.

Excess cold weather death due to indoor cold (WDI) is thus calculated as follows:

$$WDI = ECWDc \times AINc$$

EWCDc: Total excess cold weather mortality in a specific country

AINc: Share of ECWDs attributable to indoor cold in a specific country

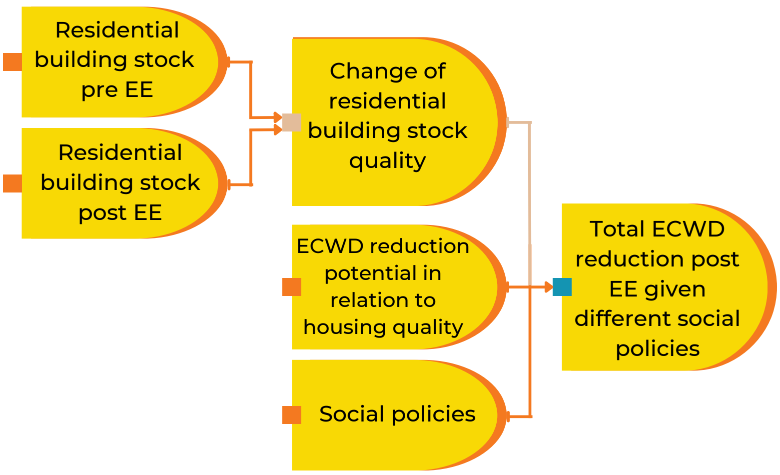

Figure 2 : Main calculation steps

According to expert observations, only a part of ECWDs can be attributable to indoor cold (Eurowinter Group, 1997; Braubach *et al.*, 2011). Thus, a second modelling step is the attribution of premature mortality due to indoor cold exposure. It is assumed that this part of ECWDs could be avoided if thermal comfort could be ensured for all members of the population in question.

No robust methodologies are available yet to estimate the attribution of ECWDs to pro-longed indoor cold exposure. Thus, expert observations have been used to estimate excess seasonal mortality. Mzavanadze (2018) found only a few European countries with expert estimates on the excess winter deaths attributed to indoor cold, with a value ranging from 10% to 50%. Ideally, such expert observation would be available for every European country. The WHO suggests a universal 30 % attribution value to indoor cold for Europe (Braubach *et al.*, 2011). However, such a universal value for Europe is not robust, considering various social welfare systems and thermal comfort standards in different countries. Thus, MICAT applies a customized attribution as proposed in the COMBI project (Mzavanadze 2018) based on the EU SILC indicator "Population unable to keep home adequately warm by poverty status" of each country (Table 1). The underlying assumption is the more people are exposed to prolonged indoor cold in the society, the bigger the likelihood of a larger share of ECWDs attributable to indoor cold.

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Share of population unable to keep home adequately warm	ECWDs attributable to indoor cold
x < 5%	10%
5% < x < 10%	20%
x > 10%	30%

Table 1: Proxies for attribution of excess cold weather deaths to indoor cold. Source: (Mzavanadze, 2018)

Ex-ante and ex-post evaluation

The extent of renovation activities and their energy efficiency level are vital for modelling the potential for excess cold weather mortality reduction. Long-term observational studies have observed a generally positive relationship between improved thermal indoor comfort and reduced ECWD (Wilkinson *et al.*, 2001). However, no scientific studies have quantified the relationship between different types of building thermal performance improvements and specific mortality reduction. For instance, deep retrofits are more likely to solve the thermal indoor discomfort rather than light retrofits, which in some cases may be insufficient to achieve thermal comfort. Mzavanadze (2018) proposes a different set of assumptions around different types of housing stock quality changes based on expert judgement. Table 2 shows the assumed relationship between attribution (AIN) reduction (and, thus, WDI reduction potential) and implemented energy retrofits.

Building energy quality	AIN and WDI reduction potential
No retrofits	0%
Light retrofits	50%
Medium retrofits	80%
Deep retrofits	100%

Table 2 : Assumptions of reduction potential of ECWD due to indoor cold in relation to housing quality

The population experiencing energy poverty suffers mostly from indoor cold due to their limited financial capacity to afford the heating service needed for cold winters. This group often lacks the financial resources for relatively costly energy efficiency interventions. Therefore, we also introduce a Policy Targetedness Factor (value between 0 and 1)[1]. It represents the percentage of energy renovation of a specific policy or programme targeting energy-poor households.

Methodological challenges

The following estimates and assumptions are associated with high uncertainties:

- The share of ECWD attributable to indoor cold was derived from a limited number of studies.
- The assumptions on the relationship between ECWD reduction potential and energy retrofits is based on judgement of a small group of experts.

[1] See MICAT factsheet "Energy poverty alleviation".

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Data requirements

Input data from scenarios/policy measures evaluations

- Default from PRIMES: Deep renovation rate of residential building stock
- Alternatively user defined:
  - Building stock
  - Number of induced / implemented renovations per year (default: all renovations are deep)

External data sources used for quantification

- EWCD of a specific country (Mzavanadze, 2018)
- Population unable to keep home adequately warm
  - National level: EU SILC "share of the population unable to keep home adequately warm"
  - City/local level: downscaling from national data above or based on surveys

Assumptions taken

- Assumptions on the relationship between ECWD reduction potential and energy retrofit levels
- The share of ECWDs attributable to indoor cold
- The assumption on the extent of social policies – to what extent energy efficiency policies and investments reach the population experiencing energy poverty

Impact factor/functional relationship

$$\Delta WDI = WDI_0 \bullet PTF \bullet \sum_{i=1}^{3} \Delta\%r_i \bullet \Delta WDI_i$$

ΔWDI : Reduction of excess cold weather mortality attributable to indoor cold
WDI_0 : Total excess cold weather mortality reduction attributable to indoor cold in the base year
PTF: Policy Targetedness Factor (value between 0 and 1)
$\Delta\%r_i$: the change of a specific building renovation type (1: light retrofit; 2: medium retrofit; 3: deep retrofit)
ΔWDI_i: WDI reduction potential due to specific building renovation type

In the default case, we assume an optimal case of energy renovation, i.e., all energy renovations would be deep from 2021 on, with a reduction potential of WDI by 100%.

The default value of PTF is derived from Article 8 of the proposed EED recast: "Member States shall achieve a share of the required amount of cumulative end-use energy savings among people affected by energy poverty vulnerable customers". If a Member State had not notified this share as assessed in their National Energy and Climate Plan, the share of the required amount of cumulative end-use energy savings among people affected by energy poverty should at least equal the arithmetic average share of one of the following indicators: the inability to keep home adequately warm, arrears on utility bills, and structure of consumption expenditure by income quintile and COICOP consumption purpose (European Commission, 2021). In the MICATool, the share of population that is unable to keep the home adequately warm of a previous year is selected as the default value for PTF.

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Monetization

The valuation of health benefits, such as the potential to reduce excess mortality, can be based on a) market values (e.g., average cost in the health care system of treating an illness, medication costs, lost productivity due to sick days) and/or b) non-market values based on surveys to determine the value of a statistical life (VSL) or value of a life year (VOLY). The market value approach requires a systematic inquiry into the health care systems of specific countries. Since health care and associated welfare system varies greatly from country to country in the EU, the first approach is not practical for MICAT, the non-market values approach is applied. VSL represents the individual willingness to pay (WTP) for small changes in the likelihood of death in a specific period. It is not a value placed on preventing a death with certainty, which is often misinterpreted (Robinson *et al.*, 2019).

OECD (2011) recommends using VSL for the monetization of health impacts related to air pollution. Other studies, e.g., Hurley et al. (2005) and Chiabai *et al.* (2018), argue that assigning a full statistical life for short-term exposure to air pollution, causing minor changes in death likelihood, might be exaggerating and suggest to use VOLY. However, little empirical research is available for VOLY.

Due to different stakeholder preferences with respect to monetisation, it is foreseen that users of the MICATool can choose between the two options.

Option 1 follows the OECD's approach, where VSL is applied to monetise both premature mortality and asthma reduction. Option 2 adopts VOLY. This is particularly suitable if the population affected is pre-dominantly elderly people. It represents a conservative approach, which is also recommended for multiple impact assessments of energy efficiency measures by Mzavanadze (2018).

The economic value of avoided premature excess cold weather mortality (VECc) in a specific country is calculated as follow:

$$VEC_c = VOLY_c \times \Delta ECWD_c$$

or

$$VEC_c = VSL_c \times \Delta ECWD_c$$

$VOLY_c$: value of a life year in a specific country
VSL_c : the value of a statistical life in a specific country
$\Delta ECWD_c$: reduced excess cold weather mortality in a specific country

In MICAT, the country-specific VOLY and VSL values of Spadaro *et al.*, (2018) are applied.

Conclusion:

Indoor cold, which generally affects energy-poor households, has direct and immediate impacts on their health, namely, excess cold weather mortality. Thus, if they are targeted, energy renovation policies or programmes would have the most substantial positive impact on this societal segment. This indicator reflects the avoided excess cold weather mortality due to energy renovations with different levels of policy commitment to address energy poor households. While default values from PRIMES are used, users can also define the buildings to be renovated and the share of energy renovations of a specific policy or programme targeting energy-poor households.

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