MICAT
Multiple Impacts Calculation Tool

Empirical basis of Environmental Impacts Energy (cost) savings

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Executive summary

This indicator describes the energy saved with the proposed measures. This is done for final and primary energy consumption, the latter taking the conversion processes necessary for the generation of hydrogen and synthetic fuels, electricity, and heat into account. In the course of the monetisation, the value of the saved fuels is assessed.

While the characterisation as a multiple impact rather than as the main impact can be debated, it is highly relevant to quantify it for a meaningful cost-benefit analysis.

This indicator has a high relevance at all governance levels, since the energy and accompanying cost savings are accruing at the implementation level. Thus, this results in low energy bills for their constituents, a major interest of all involved government levels.

This impact has several possible overlaps with other indicators, such as import dependency, material resources, avoided investments in grid and capacity expansion, and alleviation of energy poverty and equality. However, since it is the central indicator of energy efficiency, it will be the one to be monetised and the avoidance of double counting will be done in the course of monetising the other conflicting MI.

It is calculated by multiplying the savings from the different improvement actions with their respective fuel split allocation vector, resulting in the savings disaggregated by final energy carrier:

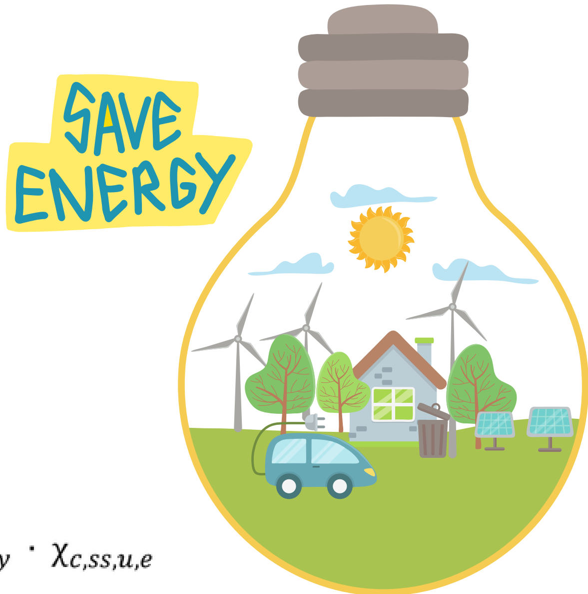
$$\Delta E_{c,ss,u,e,y} = \Delta E_{c,ss,u,y} \cdot \lambda_{c,ss,u,e,y} = \Delta E_{c,ss,u,y} \cdot \lambda_{c,ss,e,y} \cdot \chi_{c,ss,u,e}$$

In this equation, $\Delta E_{c,ss,u,y}$ describes the generated energy savings, $\lambda_{c,ss,u,e,y}$ the assumed relevant improvement action fuel mix, $\lambda_{c,ss,e,y}$ the (sub-)sectoral fuel mix, and $\chi_{c,ss,u,e}$ the assumed ratio between improvement action and (sub-)sectoral fuel mix vectors, issued from models, in this case PRIMES.

The indicator will be monetised using energy price data from Enerdata. These include taxes and differ between sectors. The energy cost $\xi \Delta E_{c,e,ss,u,y}$ are calculated using the following formula ($EP_{c,e,s,y}$ being the energy prices):

$$\xi \Delta E_{c,e,ss,u,y} = \Delta E_{c,e,ss,u,y} \cdot EP_{c,e,s,y}$$

This indicator can be aggregated with any monetised multiple impact representing a profit and not merely a turnover.



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Scope of MI Indicator

Definition

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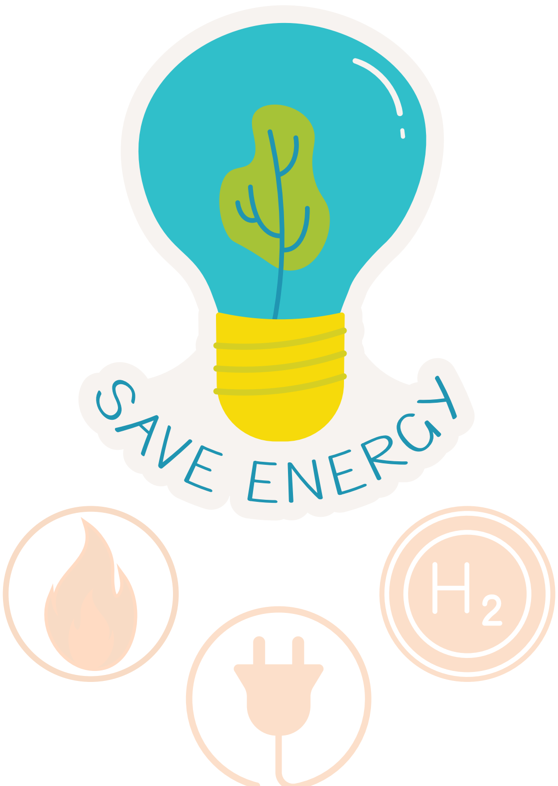

Relevance on EU, national and/or local level

This indicator has a high relevance at all governance levels, since the energy and accompanying cost savings are accruing at the implementation level. Thus, this results in low energy bills for their constituents, a major interest of all involved government levels.

Impact pathway figure

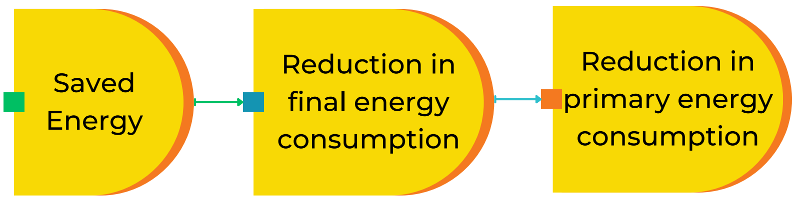

Figure 1 : Impact pathway figure of the indicator energy (cost) savings

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

This impact has several possible overlaps with other indicators, such as import dependency, material resources, avoided investments in grid and capacity expansion, and alleviation of energy poverty and equality. However, since it is the central indicator of energy efficiency, it will be the one to be monetised and the avoidance of double counting will be done in the course of monetising the other conflicting MI.

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Quantification method

Description

The quantification of final energy savings is straightforward and merely involves the allocation of a fuel mix to every improvement action and make it possible to generate it from the relevant (sub-)sector's energy mix. Thus, for every improvement action, a vector describing the ratio of a given energy carrier's prevalence in the energy savings compared to the prevalence in the whole (sub-)sector's consumption is calculated. This vector can be multiplied with any new (sub-)sectoral fuel mix, then normalised, resulting in an improvement action-level fuel split. Multiplying the savings from the different improvement actions with their respective fuel split allocation vector results in the savings disaggregated by final energy carrier:

$$\Delta E_{c,ss,\ u,e,y} = \Delta E_{c,ss,u,y} \bullet \lambda_{c,ss,u,e,y}$$

$$= \Delta E_{c,ss,u,y} \bullet \lambda_{c,ss,e,y} \bullet \chi_{c,ss,u,e}$$

In this equation, $\Delta E_{c,ss,u,y}$ describes the generated energy savings, $\lambda_{c,ss,u,e,y}$ the assumed relevant improvement action fuel mix, $\lambda_{c,ss,e,y}$ the (sub-)sectoral fuel mix, and $\chi_{c,ss,u,e}$ the assumed ratio between improvement action and (sub-)sectoral fuel mix vectors, issued from models, in this case PRIMES. The underlying assumption is that, in case the user does not specify which energy carriers are saved, the proportion of energy carriers among the savings are identical to their share of the energy mix typical for the relevant improvement action.

In order to calculate the primary energy savings, the final energy consumption is translated into primary energy consumption (the lists of final and primary energy carriers are shown in Table 1). This is done by remapping hardly transformed energy carriers (oil, coal, gas, and biomass and waste) to the list of primary energy carriers and calculate the conversion of transformed energy carriers (electricity, heat, and H2 and e-fuels).

The formula for this is shown below:

$$\Delta E_{\mathrm{P},e,ss,u,y} = \Delta E_{\mathrm{P_{con}},e,ss,u,y} + \Delta E_{\mathrm{P_{map}}e,ss,u,y}$$

$\Delta E_{\mathrm{P_{con}},e,ss,u,y} =$ Converted primary energy saving from electricity and heat generation

$\Delta E_{\mathrm{P_{map}}e,ss,u,y} =$ Mapping of $\Delta E_{e,ss,u,y}$ to primary energy carriers

$\Delta E_{e,ss,u,y} =$ Additional primary energy savings from final energy savings without conversion

id	Final energy carriers	Primary energy carriers
1	Electricity	Oil
2	Oil	Coal
3	Coal	Gas
4	Gas	Biomass and renewable waste
5	Biomass and waste	Renewable energy sources
6	Heat	Others
7	H2 and e-fuels	

Table 1 : List of MICAT final and primary energy carriers

The conversion is using data from Eurostat to assess the energy carriers that flow into the generation of electricity and heat. In a first stage, hydrogen and e-fuels are defined to be generated from electricity (such as electrolysis).

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This results in the following formula:

$$\Delta E_{\mathrm{P_{con}},e,ss,u,y} = k_{\mathrm{heat},e,y} \cdot \Delta E_{\mathrm{heat},ss,u,y} + k_{\mathrm{elec},e,y} \cdot (\Delta E_{\mathrm{elec},ss,u,y} + k_{\mathrm{h2},y} \cdot \Delta E_{\mathrm{H2},ss,u,y})$$

$\Delta E_{\mathrm{P_{con}},e,ss,u,y}$: Conventional primary energy saving for energy carrier e and year y for heat and electricity

$k_{\mathrm{heat},e,y}$: Coefficient for heat (=> new id_parameter 20)

$k_{\mathrm{elec},e,y}$: Coefficient for electricity (=> new id_parameter 21)

$k_{\mathrm{H2},e,y}$: Coefficient for electricity (=> new id_parameter 22)

$\Delta E_{\mathrm{elec},ss,u,y}$ = Final energy saving for electricity (= $\Delta E_{e,ss,u,y}$ for e=1)

$\Delta E_{\mathrm{heat},ss,u,y}$ = Final energy saving for heat (= $\Delta E_{e,ss,u,y}$ for e=7)

$\Delta E_{\mathrm{H2},ss,u,y}$ = Final energy saving for hydrogen and synthetic carburants (= $\Delta E_{e,ss,u,y}$ for e=8)

The calculation of the coefficients for electricity and heat takes cogeneration into account. This requires to decide for an accounting method, to allocate the energy consumption of the cogeneration plant to the outputs electricity and heat. For MICAT, an equivalent number approach has been selected, assuming the ratio of efficiency between electricity and heat efficiency is the same in a cogeneration plant as it is between two standalone electricity and heat plants.

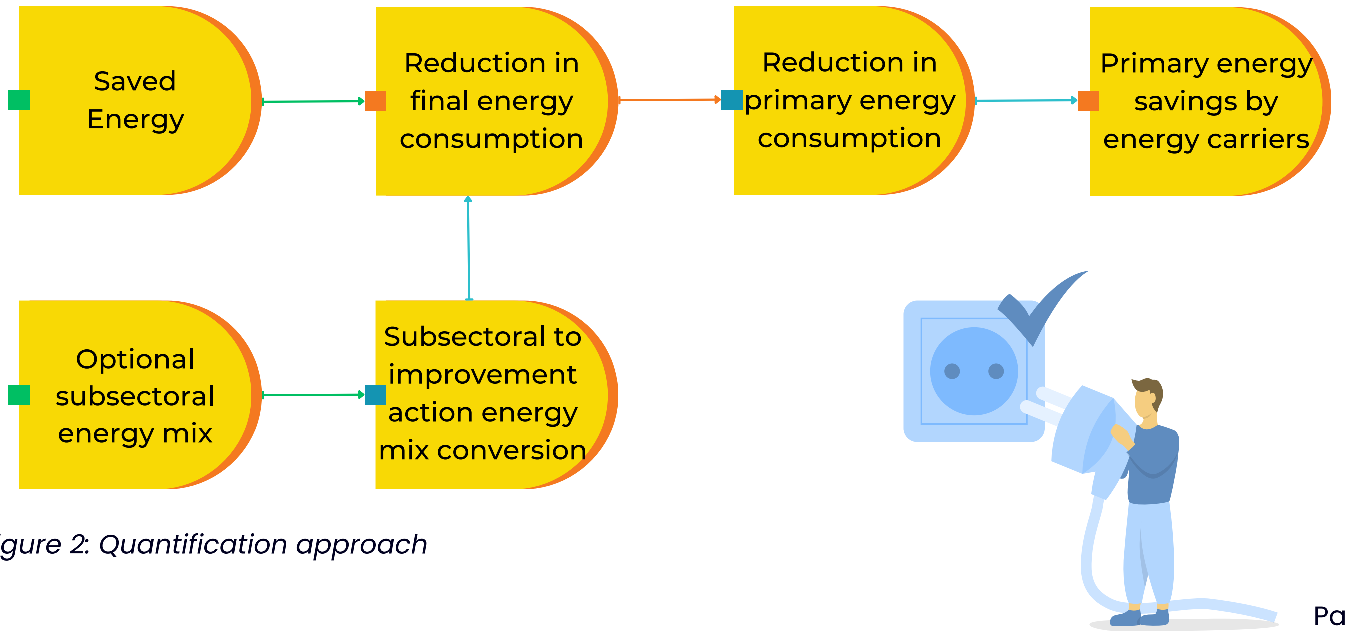

Figure 2: Quantification approach

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Methodological challenges

Some countries do not have dedicated heat plants, which are needed to calculate the efficiency of a country's heat generation, which in turn is necessary for the calculation of the equivalent number approach for cogeneration. To circumvent the issue, the average efficiency of heat plants is used for those countries.

Data requirements

- Eurostat and PRIMES energy balances (ex-post and ex-ante, respectively)
- A reference scenario to calculate the subsectoral-to-improvement-action-energy-mix-coefficients, in this case originating from PRIMES
- Predictions of efficiency developments of H2 and e-fuel-generation

Impact factor/functional relationship

The functional relationship is described in the quantification part.

Monetization

The indicator will be monetised using energy price data from Enerdata. These include taxes and differ between sectors. The energy cost savings $\xi\Delta E_{c,e,ss,u,y}$ are calculated using the following formula ($EP_{c,e,s,\ y}$ being the energy prices):

$$\xi\Delta E_{c,e,ss,u,y} = \Delta E_{c,e,ss,u,y} \cdot EP_{c,e,s,\ y}$$

This database covers the past but not the future. Thus, the prices are projected using either data from PRIMES or from the IEA World Energy Outlook. Since some data points are missing, a three-stepped approach to estimating missing values has been used:

- When merely some values are missing for a country and energy carrier in a time series, the price trend across the years is assessed along the time series of countries with full data and then multiplied with the existing data to inter- and extrapolate missing values
- When the whole time series is missing for a country, the European average is used
- When the European average is missing, the non-weighted average of the full time series is calculated and also used for countries with no data at all

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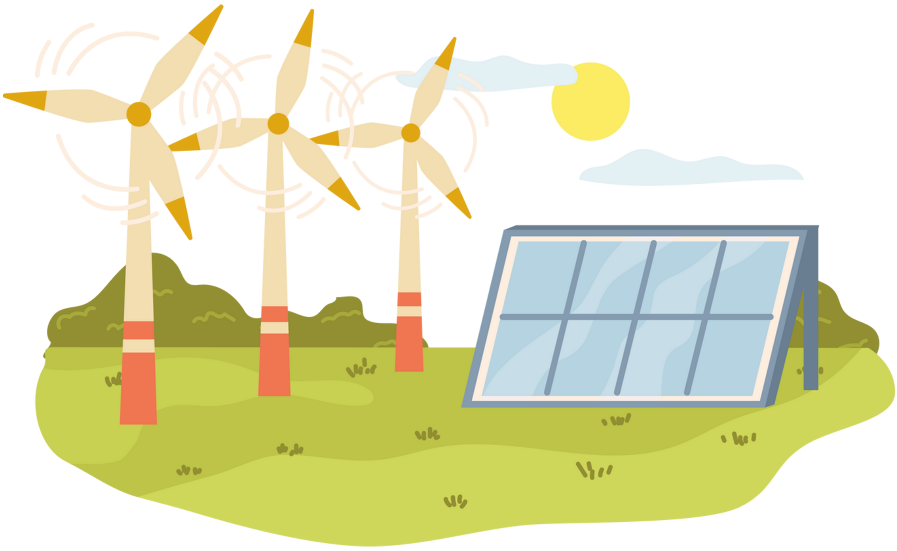
Aggregation

This indicator can be aggregated with any monetised multiple impact representing a profit and not merely a turnover.



Conclusion:

This indicator is central to energy efficiency and sufficiency, as it represents the main motivation to invest in measures. As a consequence, it is also relevant on all three governance levels. Thus, a sound quantification and monetisation is paramount.

Although there is a severe risk of double counting with a number of other indicators, this should not mean that this indicator is shelved, as it is the most important indicator among those it might risk double counting with.