Multiple Impacts Calculation Tool

Empirical Basis of Environmental Impacts GHG Savings: Savings of Direct Carbon Emissions

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Executive summary

- This indicator describes the CO_2 emissions saved as a result of energy efficiency measures. Nearly all combustion processes emit greenhouse gases, causing climate change through the greenhouse effect.

- Other greenhouse gases might also be reduced (or increased) as a result of an energy efficiency measure. However, these effects are neglected here, as they typically do not affect the GHG balance significantly.

- Biomass combustion here is not considered necessarily carbon neutral, as the biomass combusted may not have been produced entirely sustainably.

- The resulting equation for the saved CO_2-emissions $\Delta CO2_{c,e,ss,u,y}$ is the following: $\Delta CO2_{c,e,ss,u,y} = k_{CO2,\, c,e,ss,y} \cdot \Delta E_{c,e,ss,u,y}$

- In this equation, $k_{CO2,\, c,e,ss,y}$ represents the specific CO_2-emission factor for a given region, energy carrier, subsector, and year, whereas $\Delta E_{c,e,ss,u,y}$ specifies the energy savings generated in a given region, energy carrier, subsector, improvement action, and year.

- The only data requirements for this indicator are the CO_2-emission coefficients for each region-energy carrier-subsector-year-combination as well as one monetisation factor which has to be corrected for inflation.

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Scope of MI indicator

Definition

Within MICAT, this indicator measures the impact of energy efficiency measures on greenhouse gas (GHG) emissions, specifically emissions of CO2.

The indicator takes into account the amount(s) of fuel(s) being saved, as well as CO2 emission factors that are fuel-specific, and in principle also country-specific (the country-specificity is most relevant for coal, as the calorific values of lignite and hard coal different, and different countries use lignite and hard coal in different proportions).

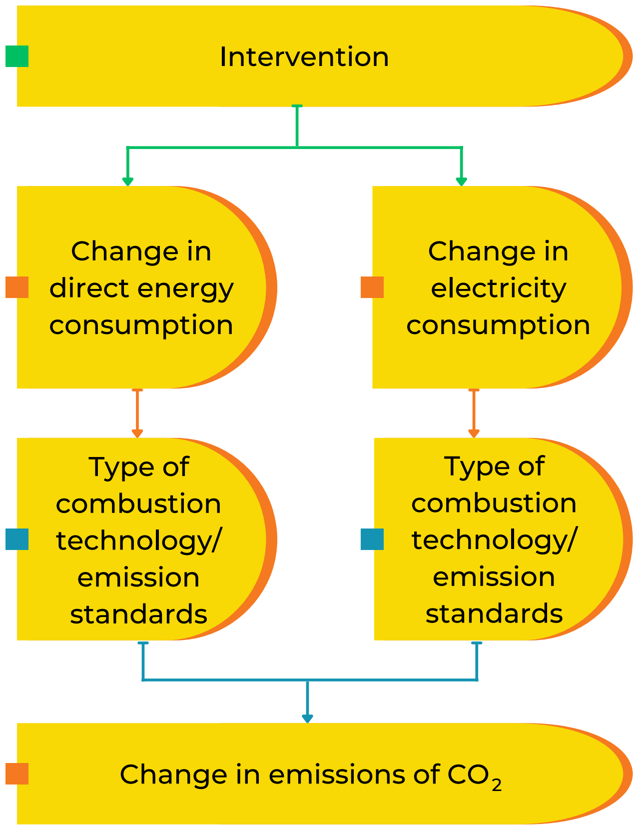

Figure 1: Impact Pathway and calculation method for changes in GHG/CO2 Emissions from energy efficiency measures

Relevance on EU, national and/or local level

Reducing GHG emissions is the key objective of climate mitigation policies at all governance levels and their relevance is permeating all energy-related policies.

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

No overlap has been identified.

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Quantification method

Description

Energy efficiency measures GHG emissions through the channel described in Figure 1.

1

In a first step, quantify the amount of energy (direct combustion and electricity) saved by an intervention. Such an intervention can affect the direct consumption of fuel as well as the consumption of electricity. For example, heat pumps replace direct combustion, but consume electricity.

2

Secondly, determine the corresponding supply-side changes in the use of technologies. For example, saving electricity would result in less electricity being produced. An assumption needs to be made about what kind of source of electricity is being reduced, whether the most carbon-intensive (coal-based electricity), or an average (country) fuel mix, or else. Moreover, for the emission characteristics further assumptions would need to be made whether, in the case of thermal power plants, whether the cleanest, the dirtiest, or the average device (in terms of air pollutants) are assumed to be reduced. Finally, if the energy efficiency measure reduces direct combustion of fuel, the emission characteristics of that reduction needs to be specified. For example, increasing the energy efficiency of a particular process in the chemical industry may result in all direct fuel uses being reduced proportionally, or may result in only one particular fuel (e.g., gas) being reduced, and again the vintage of the installation may be relevant. The allocation of saved fuels is done using default values representing the average energy mix of the selected improvement action in the relevant subsector or user-defined values.

3

Lastly, calculate the resulting changes in the emissions of carbon dioxide.

All calculations (e.g., energy saved, emissions) are performed on an annual basis and at the level of individual member states of the EU. These results can easily be aggregated.

Methodological challenges

- In principle, CO2 emission factors on an energy basis depend on the fuel quality. However, differences among different domestic and import sources are typically small and are neglected here. Differences in net calorific values may be larger.
- Emission reductions of non-CO2 greenhouse gases have not been estimated, as this requires a detailed assessment of the changes in the upstream emissions (e.g., methane from mining and pipeline transport) or the exact power distribution technologies (e.g., SF6 in switches).
- Biomass combustion is sometimes considered carbon neutral, as biomass can be grown sustainably. However, this is a simplistic and potentially misleading assumption, and there are studies that estimate significant net emissions factors for biomass combustion. A central value from these studies is being used in the tool.

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Data requirements

- The analysis is performed with GAINS model (Amann et al., 2011) which typically uses, for Europe, PRIMES energy system data for analysis of alternative scenarios, though for the assessment of interventions the link to PRIMES is actually not required.
- For CO_2 emission calculations, the IPCC tier 1 method is used (IPCC, 2006).
- For CO_2 emission factors, typically IPCC default factors have been used, unless country-specific information was available.

Impact factor / functional relationship

The CO_2 emission reductions are calculated as follows:

$$\Delta CO2^{i} = \sum_{s,u,t,e} EF_{i,s,u,t,e,CO2} \times \Delta E^{i}_{c,s,u,t,e}$$

The independent variable ΔE^{i}_{c} describes how an intervention *i* in country *c* affects the energy consumption of carrier *e* using technology *t* for end-use in sector *s*. The factor *EF* describes the emission factor relevant for the change in energy consumption ΔE.

Strictly speaking, the factors *EF* may depend on scenario assumptions, as they can reflect different fuel mixes, though the calculation can of course be performed fuel by fuel. The main scenario dependence lies in the independent variables ΔE^{i}_{c}, i.e., in the narrative and specification of how an energy saving intervention *i* actually affects the consumption of different fuel uses in different sectors etc.

Monetisation

The easiest way to monetize CO_2 emissions (or reductions thereof) is to multiply them with the price in a given carbon market, for example, the European ETS. Thus, the CO_2-savings $\Delta CO2_{c,ss,u,y}$ are multiplied with a monetisation coefficient $kCO2_{y}$:

$$\xi CO2_{c,ss,u,y} = \Delta CO2_{c,ss,u,y} \cdot kCO2_{y}$$

Alternatively, the so-called social cost of carbon could be used, which typically represents higher values than actual and projected carbon price values.

The coefficient used in the MICAT tool comes from the German Federal Environmental Agency and assumes costs of 199 €/tCO_2 in 2020, 219 €/tCO_2 in 2030, and 255€/tCO_2 in 2050. All monetary values are stated in €2021.

Aggregation

Member state data can be aggregated to the EU level and also downscaled to the city level.

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Conclusion

This indicator describes the reductions of CO2 associated with energy efficiency measures. The emission reductions of other greenhouse gases are typically smaller (in GWP equivalent units) and are much more difficult to quantify as they depend on the upstream energy production system (wells, mines, pipelines) and assumptions on how marginal changes in the energy system affect the upstream operations. Hence these are not quantified here. CO2 emission reductions can be monetized by multiplying them with a corresponding carbon market price or the social cost of carbon.

References

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