MICAT

Multiple Impacts Calculation Tool

# Empirical Basis of Economic Impacts Sectoral Shifts

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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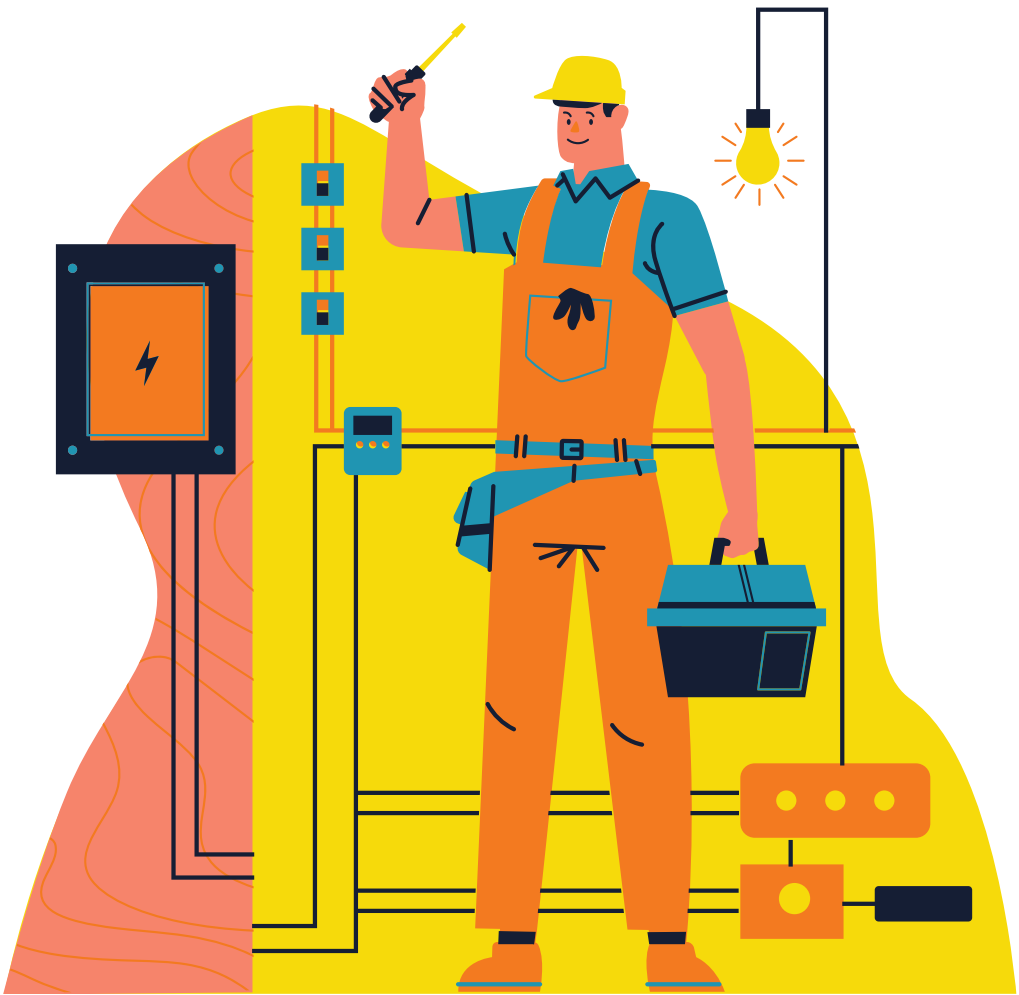
# Executive summary

Within MICAT, this indicator describes the impacts of energy saving measures on sectoral employment and value added. Energy efficiency measures create demand for products with subsequent sectoral shift implications for both value added and employment generation. We follow a static multiplier approach to estimate the creation (or reduction) of value added/employment by aggregate sectors due to the additional demand that is to deliver the investments associated with the energy saving measures. A key step is the calculation of the gross value added multipliers based on IO-Analysis, providing a quantification of the employment and the gross value added that will be generated in the economy by 1 million euro of new final demand. The method is then applied on six aggregate sectors of the economy and does not report the economy-wide effect as in the case of the GDP/Employment indicator. The aggregate sectors are Agriculture, Energy, Manufacturing, Construction, Transport, Services. The approach considers the share of imported goods, the direct and indirect effects through the structure of the IO table. The methodology assumes only the impacts generated from additional demand, thus not assuming any other structural changes, e.g., due to the drop of activity in certain sectors, nor the effects of changes in income and prices. Finally, the methodology relies on the allocation of investment expenditure to demand by economic activities, which is based on expert judgement and assumed uniform by country and sector that applies the measures.



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# Scope of MI indicator

## Definition

Energy efficiency measures create demand for products with subsequent sectoral shift implications for both value added and employment generation. We follow a static multiplier approach to estimate the creation (or reduction) of value added/employment by aggregate sectors due to the additional demand that is to deliver the investments associated with the energy saving measures. Here we limit the analysis to a static approach, by assuming the additional generated demand without assuming any crowding out or substitution of existing demand or investments. Similarly, we do not make any explicit assumptions on the financing of the measures, and we do not consider any impacts due to changes in incomes and prices.

## Relevance on EU, national and/or local level

Sectoral shifts are of primary importance for all levels of policy assessment, including the EU, national and local level, being also relevant to elements of just transition. The indicator can be applied to all levels depending on data availability.

## Impact pathway figure

The methodology adopted to perform the assessment of the sectoral shift indicator of the different energy saving measures is composed by the following steps:

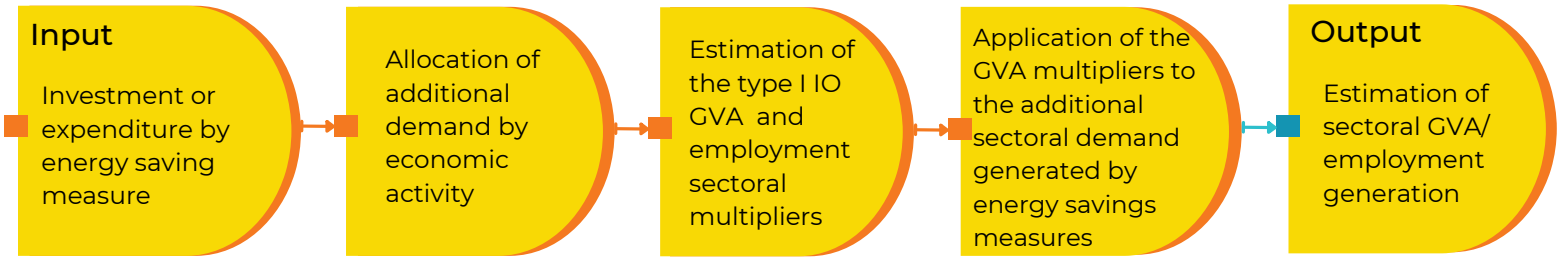


*Figure 1*: *Quantification steps for the estimation of the Sectoral Shift MI indicator*

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

There is no risk of overlaps or double-counting with other MI indicators.

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# Quantification method

## Description

The methodology to estimate the sectoral shifts has as a starting point the method to derive the overall GDP and Employment impacts A key step is the calculation of the gross value added multipliers based on IO-Analysis, providing a quantification of the employment and the gross value added that will be generated in the economy by 1 m. € of new final demand. The method is then applied on six aggregate sectors of the economy and does not only cover the economy-wide effect as in the case of the GDP/Employment indicator. The approach considers the share of imported goods, the direct and indirect effects through the structure of the IO table. As described in Figure 1, we follow the steps shown below for the quantification of this indicator.

### Steps

1. Receive as input the investment expenditure by type of energy saving measure
2. Calculation of type I gross value added/employment sectoral multipliers based on the IO table
3. Associate the investment expenditure to specific demand of goods and services to allocate the additional generated demand by economic activity
4. Application of the respective multipliers by economic activity and by type of energy efficiency measure
5. Estimation of the impacts in the 6 aggregate economic sectors, as shown below

### Sectors of the Economy

$sec_1$ : Agriculture

$sec_2$ : Energy

$sec_3$ : Manufacturing

$sec_4$ : Construction

$sec_5$ : Transport

$sec_6$ : Services

In the **second step**, the Leontief type I multipliers are calculated by sector and by country given the technology coefficients and the consumption preferences of a given economy. This type of analysis does not consider capacity constraints and thus no consideration is taken for the change in prices and the markets of primary factors. The technical coefficient matrix A consists of all technical coefficients as its elements $a_{ij}$. For every country and for each branch the technical coefficient $a_{ij}$ is calculated as the ratio of the intermediate consumption to total supply for each industry. The sectoral multiplier effect is calculated based on the following formula:

$$coeffEMPL_{i,j} = EMPLRT_i \cdot L_{i,j} \quad (1)$$

$$coeffGVA_{i,j} = GVART_i \cdot L_{i,j} \quad (1')$$

where:

$EMPLRT_i$ : the ratio of number of employees to total supply for the industry *I*, measured in jobs per million € coefficients derived by the IO table

$GVART_i$ : the ratio of gross value added to total supply for the industry I derived by the IO table

$L_{i,j}$ : the *ij*-element of the Leontief inverse Matrix $L = (I - A)^{-1}$, where *i* is the sector providing intermediate inputs to the production of sector *j*

$coeffEMPL_{i,j}$ : the total number of employees that will be generated in the economy for an additional demand of 1 m€ in sector *j* by sector *i*

$coeffGVA_{i,j}$: the total gross value added that will be generated in the economy for an additional demand of 1 m€ in sector *j* by sector *i*

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## Leontief Inverse Matrix L

$$L = (I - A)^{-1} \qquad (2)$$

where:

$I$ : Identity matrix

$A$ : Direct requirements matrix, the ratio of the intermediate consumption to total supply for each industry


## Impact factor / functional relationship

The **third step** of our methodological approach assumes a table that associates the investment expenditure of each energy efficiency measure to the specific demand of one goods and services. This table aims to allocate the additional generated demand to each of the 65 identified economic activities so that the impacts of energy efficiency measures are dispersed over a number of NACE sectors. The table has been constructed according to expert judgement and thus changing the default assumptions of sectoral allocation by energy efficiency measure can be redefined by the users. Below, in Table 1 we provide a few examples of the allocation of demand by economic activity for the measures of "Building envelope", "Heating fuel switch", and "Energy efficient heating". The numbers in Table 1 express the shares by which the investment expenditure is allocated to each economic activity.

*Table 1: Examples of sectoral allocation of investment expenditure by energy saving measures*

| Economic Activity | NACE code | Building Envelope | Heating Fuel Switch | Energy-efficient Heating |
|---|---|---|---|---|
| Other non-metallic mineral products | C23 | 20% | | |
| Basic metals | C24 | 20% | | |
| Computer, electronic and optical products | C26 | | | 5% |
| Electrical equipment | C27 | | 15% | 5% |
| Machinery and equipment n.e.c. | C28 | | 50% | 50% |
| Repair and installation services of machinery and equipment | C33 | | 10% | 15% |
| Constructions and construction works | F | 40% | 10% | 10% |
| Retail trade services, except of motor vehicles and motorcycles | G47 | 10% | 10% | 10% |
| Architectural and engineering services; technical testing and analysis services | M71 | 10% | 5% | 5% |

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As a next step, we estimate the annual additional value added generated in each aggregate sector by an investment of 1 m€ for energy saving measures. The sectoral allocation of demand is derived by the respective share in Table 1 and determines how the additional demand from 1 m€ of investment in energy saving measures is allocated to sectors. Based on this allocation, the total effect in GVA from 1 m€ investment in energy saving measures is calculated by multiplying each of the additional demand allocated to sectors with the respective gross value added coefficient as calculated in step one, see equation (3).

$$coeffTOTEMPL_{i,m,c} = \sum_{j} coeffEMPL_{i,j,m,c} \cdot es_{j,m} \quad (3)$$

$$coeffTOTGVA_{i,m,c} = \sum_{j} coeffGVA_{i,j,m,c} \cdot es_{j,m} \quad (3')$$

where:

*i,j* : sectors / activities

*m* : measure / end-use

*c* : country

$es_{j,m}$ : allocation share of Energy Saving Investment (m) to sector (j)

At the **final step**, we estimate the employment and GVA generation for each aggregate economic sector by applying the level of expenditure by type of measure with the employment and gross value added sectoral effect generated in the total economy by 1 m€ expenditure, see equation (4).

## Methodological challenges

The 2015 SIOT tables from Bulgaria are not available on Eurostat. Czechia, Ireland, Luxemburg and Malta data are deficient. Sweden data are unbalanced (i.e., SIOT is not symmetric) however this country is not excluded. The sectoral employment and GVA impact of certain energy saving measures cannot be quantified, thus by default cannot be calculated, as these cannot be associated with the purchase of specific economic activities or are too generic. The methodology assumes only the impacts generated from additional demand, thus not assuming any other structural changes, e.g. due to the drop of activity in certain sectors, nor the effects of changes in income and prices. Finally, the methodology relies on the allocation of investment expenditure to demand by economic activities, which is based on expert judgement and assumed uniform by country and sector that applies the measures.

## Data requirements

The starting point of the analysis is the latest available Symmetric Input Output tables (SIOT) by EU Member State, which are available in Eurostat for year 2015. The sectoral resolution adopted in our analysis is the 65 sectors in NACE rev2. 2-digit, in line with the CPA resolution. Additionally, the sectoral demand contributions should be assumed.

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# Impact factor/functional relationship

The associated additional employment and value added per aggregate sector is proportional to the energy saving investments. Every investment in energy saving measure is attributed to sectors and the total sectoral effect is calculated as shown below:

$$SECEMPL_{sec(j),m,c,y} = \sum_{\text{if } i \in sec(j)} coeffTOTEMPL_{i,m,c} \cdot Inv_y \quad (4)$$

$$SECGVA_{sec\,(j),m,c,y} = \sum_{\text{if } i \in sec(j)} coeffTOTGVA_{i,m,c} \cdot Inv_y \quad (4')$$

where,

$i$ : sectors /activities

sec($j$) = 1,2,...,6 – for example, if $j$ = 4, then $sec_4$ = construction

$m$ : measure / end-use

$c$ : country

$y$ : year

$INV_y$: Energy Saving Investments

## Monetisation

The GVA sectoral shifts are already expressed in terms of million EUR. The employment-related shifts can be monetized if associated with a mean wage by country and sector.

## Aggregation

The indicator can be directly aggregated with other indicators but attention should be paid on potential double-counting (e.g. with the economy-wide GDP and employment indicators).

## Conclusion

Below we provide examples for the calculation of the sectoral shifts GVA indicator for three selected EU Member States, namely Germany, Italy and Poland.

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*Table 2: Calculation of the sectoral shift indicator for Germany*

| Annual investments in million € | | | | | |
|---|---|---|---|---|---|
| **Subsector** | Measure | Country | | | |
| **Machinery** | Space heating and cooling | Germany | 150 | | |
| **Coefficient for GVA Effect in m€ per m€ of investment** | | | | | |
| **Agriculture** | **Energy** | **Manufacturing** | **Construction** | **Transport** | **Services** |
| **0.0003** | 0.0048 | 0.2591 | 0.0539 | 0.0203 | 0.2850 |
| **Annual GVA generated by investment for energy saving measures** | | | | | |
| **Agriculture** | **Energy** | **Manufacturing** | **Construction** | **Transport** | **Services** |
| **0.05** | 0.72 | 38.87 | 8.09 | 3.04 | 42.74 |

For example, it can be derived that for each million € invested in the energy saving measure of space heating and cooling, 0.259 million (of totally 0.62 m.) additional GVA is generated by the manufacturing sector and 0.285 in the services sector. Thus a 150 million € investment would annually generate 38.87 million (of totally 93.5 m.) GVA in the manufacturing sector.

*Table 3: Calculation of the sectoral shift indicator for Italy*

| Annual investments in million € | | | | | |
|---|---|---|---|---|---|
| **Subsector** | Measure | Country | | | |
| **Machinery** | Building envelope | Italy | 150 | | |
| **Coefficient for employment effect in jobs per m€ of investment** | | | | | |
| **Agriculture** | **Energy** | **Manufacturing** | **Construction** | **Transport** | **Services** |
| **0.0967** | 0.0735 | 2.5793 | 4.3242 | 0.4409 | 6.3637 |
| **Annual additional employment generated by investment for energy saving measures** | | | | | |
| **Agriculture** | **Energy** | **Manufacturing** | **Construction** | **Transport** | **Services** |
| **14.50** | 11.02 | 386.89 | 648.63 | 66.14 | 954.55 |

Taking another example for the country of Italy, we estimate the impact of the energy saving measure of the building envelope. It can be derived that for each million € invested in this measure, 4.3 additional employment (of totally 13.9 employees) is generated by the construction sector, thus a 150 million € investment would annually generate 648.6 employees (of totally 2081.7) in the construction sector.

*Table 4: Calculation of the sectoral shift indicator for Poland*

| Annual investments in million € | | | | | |
|---|---|---|---|---|---|
| **Subsector** | Measure | Country | | | |
| **Machinery** | Fuel switch | Germany | 150 | | |
| **Coefficient for GVA Effect in m€ per m€ of investment** | | | | | |
| **0.0013** | 0.0113 | 0.1968 | 0.0644 | 0.0100 | 0.2047 |
| **Agriculture** | **Energy** | **Manufacturing** | **Construction** | **Transport** | **Services** |
| **Annual GVA generated by investment for energy saving measures** | | | | | |
| **Agriculture** | **Energy** | **Manufacturing** | **Construction** | **Transport** | **Services** |
| **0.20** | 1.69 | 29.53 | 9.66 | 1.50 | 30.70 |

Finally, an example for the country of Poland shows the impact of investing in fuel switch energy saving measure. It can be derived that for each million € invested in this measure, 0.21 million GVA and 0.20 (of totally 0.49 m.) is annually generated by the services and manufacturing sectors respectively. Thus a 150 million € investment would annually generate 30.70 million (of totally 73.3 m.) GVA on the services sector.