



Calculating and Operationalising  
the Multiple Benefits of  
Energy Efficiency in Europe

# WP6 Macro economy

## Draft methodology for macro-economic impact quantification

### D6.2

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# 1 Background

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## 1.1 Project description

The COMBI project aims at quantifying the multiple non-energy benefits of energy efficiency. It is coordinated by the Wuppertal Institute for Climate, Environment and Energy and implemented together with the research partners University of Antwerp, University of Manchester, Copenhagen Economics and ABUD/Advanced Buildings and Urban Design. The multiple benefits of energy efficiency are gaining relevance in the research and the current policy discourse, but scientific evidence is yet scarce and scattered. Therefore, this projects will gather existing approaches and evidence from the EU area, develop modelling approaches and come up with consolidated data on different benefits such as emissions (effects on health, ecosystems, crops, built environment), resources (biotic/abiotic, energy/non-energy), social welfare (disposable income, comfort, health), macroeconomy (labour market, public finance, GDP), and the energy system (grid, supply-side, energy security). All project outcomes will be available at an open-source online database and be analysable via a graphic online-visualisation tool for personalising the findings as to their geographic location and selected benefits. To this end, the development of an aggregation methodology is of central importance to avoid double counting and presenting the various benefits on their various dimensions. Finally, insights for policy relevance will be derived and policy recommendations will be elaborated to facilitate the communication of the non-energy benefits in the relevant policy areas. In addition, the project is in touch with on-going processes of how to include multiple energy efficiency benefits into policy evaluation.

## 1.2 Aim of this report

Based on the literature reviews conducted for individual multiple impacts (MI), the second main step of the COMBI project is to develop a methodology to quantify and monetise MIs. Monetisation of single (sub-)MI is conducted where possible. For the set of defined EEI actions (see D2.2 report), energy saving potentials in the year 2030 are being developed reflecting official EU PRIMES scenarios (energy efficiency vs. baseline scenario) (see D2.1 report). The general COMBI approach follows the additionality principle: Only additional effects (both energy and non-energy impacts) relative to an action baseline are considered (*will be adapted for final version.*)

# 2 Scope of investigation

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## 2.1 Definition of impacts, end-points and metrics/indicators

Macroeconomic impacts are either business-cycle or structural impacts. These two types of impacts are fundamentally different, and analysing them requires distinct methodologies. Both types of macroeconomic effects may also lead to effects on the public budget balance. For further discussion about the two types of macroeconomic effects, see Næss-Schmidt et al (2015).

The key focus of our work is on *short-run macroeconomic effects, or business-cycle effects*, which stem from the fact that economies go through cyclical changes in investment, output (GDP) and employment, which fluctuate around a long-run trend. Whenever GDP and employment are

below their long-run trend values, the traditional Keynesian interpretation is that Aggregate Demand, i.e. the total demand for goods and services in the economy, is too low.<sup>1</sup> Macroeconomic policy, principally monetary and fiscal policy, are carried out in order to smooth out such fluctuations, by boosting consumption or investment, and thereby Aggregate Demand, at times when it is too low. Investments in energy efficiency improvements will function as a fiscal-policy investment stimulus, and as such can potentially have positive effects on GDP and employment, under the right conditions. This applies when the investment takes the form of public spending (i.e. a fiscal-policy stimulus), but is equally true when it comes in the shape of private investment. In other words, whether the initial investment is financed by public or private funds is not important for its effect on Aggregate Demand.

Macroeconomic effects can also be *long-run, or structural, effects*. These are unrelated to short-run business-cycle fluctuations, and instead pertain to an economy's properties in equilibrium, or along the long-run growth trend. Energy efficiency improvements may lead to a range of structural effects, including the direct effect of reduced spending on energy consumption, as well as pollution and other health effects, all of which are studied in other parts of COMBI.<sup>2</sup>

Structural effects may also have a (structural, or permanent) effect on public budgets, e.g. through less public spending on energy consumption, or reduced health care spending. In addition, the EEL actions studied in COMBI are likely to lead to a number of other macroeconomic effects on fossil fuel prices and the market for greenhouse gas emission permits, which are not necessarily benefits, but nonetheless highly interesting.

The impacts analysed in WP6 are the following:

*Business-cycle (short-run) impacts:*

- Employment/GDP (these are two sides of the same coin, and not two separate impacts)

*Structural (long-run) impacts:*

- Impacts on global fossil fuel prices
- ETS implications
- Carbon leakage implications

In addition, *public budget effects* will be analysed. There will be both short-run effects, due to the employment (GDP) effects mentioned above, and long-run effects, due to the direct effect of energy efficiency improvements (lower energy bills), as well as potentially lower public spending

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<sup>1</sup> The analysis of short-run macro effects in COMBI will follow the Keynesian view on business-cycle fluctuations. There are alternative views – there is fundamental disagreement within the field of macroeconomics about what causes business-cycle fluctuations, and what the best policy response (if any) is. See Næss-Schmidt et al (2015) for further details.

<sup>2</sup> Some of these effects, such as improved productivity, may lead to increased GDP, which is a macroeconomic measure. However, the GDP effect of improved productivity corresponds to the monetized value of the productivity effect. Adding up both the monetized value of individual effects, e.g. on productivity, and the corresponding GDP effect, would amount to double counting. WP6 will therefore not focus on the structural GDP effects as a separate multiple benefit, but rather COMBI will capture this through the individual effects on productivity found in WP5.

We will not analyse structural employment effects. As is standard in macroeconomics, the structural employment level is assumed to be determined by supply-side characteristics rather than aggregate demand. The fact that the economy will consume less energy and more of other goods and services may affect the sectoral distribution of economic activity, including employment, but is not likely to affect the overall level of employment.

as a result of health improvements. In addition, higher structural GDP as well as substitution away from energy towards other goods and services will lead to changes in tax receipts, which affects public budgets.

Impact end-points, which are highlighted in pink in Figure 1 below, are:

1. Business-cycle effects on GDP/employment
2. Business-cycle public-budget effects
3. Structural public-budget effects
4. Global fossil-fuel price effects (structural)
5. EU-ETS quota price effects (structural)

As these impacts are all macroeconomic in nature, the natural metrics are already monetized, e.g. m€ (GDP), or € per barrel (oil price). End-point number 1 above has an effect can be measured in GDP as well as in the number of jobs created, where the number of jobs appears as an additional physical metric.

## 2.2 EEI actions relevant for macroeconomic impacts

In principle, all actions will be covered.

For the business-cycle effects, what matters is the amount of government consumption or investment spending associated with each action. All actions apart from the modal shifts (18, 19) are clearly associated with some (additional) investment spending, and as such have the potential to generate business-cycle effects. The modal shift actions will only have a business-cycle effect to the extent that they are linked to investment spending on, e.g., transport infrastructure, or to larger public spending on transport. Given available data on the costs associated with each action, all actions can be covered.

For the structural effects, the main consideration is the potential energy savings associated with each action, which should be available from WP2.

For public-budget effects, potential energy savings (which lead to changes in tax revenues/energy subsidies) are again an important input, as are pollution and health effects assessed by other WPs. To the extent that these results cover the different actions, this feeds through to the public-budget effects.

## 2.3 Definition of system boundaries

### 2.3.1 Life-cycle analysis: Use vs. production phase

From a macroeconomic perspective, business-cycle effects are mainly related to the production phase, whereas structural effects stem from the use phase. Indeed, the business-cycle employment effects arise when EEI actions bring into use labour resources that would otherwise have been sitting idle<sup>3</sup>. However, the business-cycle analysis will not explicitly consider energy

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<sup>3</sup> Here it should be noted that by 'idle' resources, we understand labour resources over and above the so-called natural rate of unemployment. Only when unemployment is higher than its long-run equilibrium level is there an excess of idle labour that can easily and costlessly be employed in new projects.

and resource use in the production phase. The structural analysis deals with the new macroeconomic equilibrium that will be reached once the set of actions have been implemented (and not the transition to this new equilibrium), and will as such relate to the use phase only.

### 2.3.2 Other regional system boundaries: spill-over

What matters for the short-run employment effects is the magnitude of the Aggregate Demand boost locally (e.g., domestically). If increased investment or government consumption spending mainly leads to higher imports, local employment will not be affected. Our business-cycle analysis will attempt to quantify country-level employment effects, which will include an assessment of how aggregate demand effects spill over country boundaries, both between EU countries, and to the rest of the world. This will be done using an input-output model framework.

## 2.4 Evaluation perspectives

The end-user/investor perspective will not be considered. Macroeconomic effects of the action in question are not relevant for individual end users/investors when taking investment decisions. The main evaluation perspective considered will instead be the societal one.

Public-budget effects will be covered as a separate perspective. This is necessary, since although a balanced public budget is in some sense good for society as a whole, one could think of effects that are negative for the public budget, but still positive from a societal perspective, and vice versa. Public-budget effects cannot easily be added to other societal effects, and should therefore be considered separately.

## 2.5 Distributional aspects

Macroeconomic impacts, by definition, concern the economy as a whole, and as such tend to affect everyone in the same way. For example, fossil fuel or ETS prices will experience the same changes no matter which subgroup's perspective is used, as will public budgets.

However, the *business-cycle employment effects* will affect people differently, in the sense that some will go from unemployed to employed, but most people will see no change in their employment status. For those who do switch employment status, the effect is clearly more important. Individuals who do switch employment status have, by definition, been unemployed prior to the switch, and as such they are plausibly disadvantaged (However, this may depend on whether certain skills will be required for the jobs created as a result of the corresponding actions – “the unemployed” may not be a particularly homogeneous group).

More importantly, there is a rural/urban (or perhaps centralized/local) distinction too. Rural employment is particularly weak in many parts of Europe, and as such it is of interest to what extent job creation happens in rural areas, and also to what extent it happens locally to where the EEI action is implemented.

A fully quantitative assessment of effects across these dimensions may be difficult, as that would require data on how economic activity, by sector, is distributed geographically across countries. A qualitative assessment of these issues may address to what extent investment might lead to local employment effects – more likely for actions that involve construction, e.g. improved building envelopes, than investments in machinery.

## 2.6 Context dependency

The type of financing should not matter much for the macroeconomic effects. For business-cycle effects, an increase in aggregate demand has the same on employment whether it comes from an increase in government or private spending. For structural effects, the main driver is the energy demand reduction due to the various actions, which should not depend on financing.

## 3 MI interactions and side effects

### 3.1 Impact pathways

Figure 1: Macro impact pathways

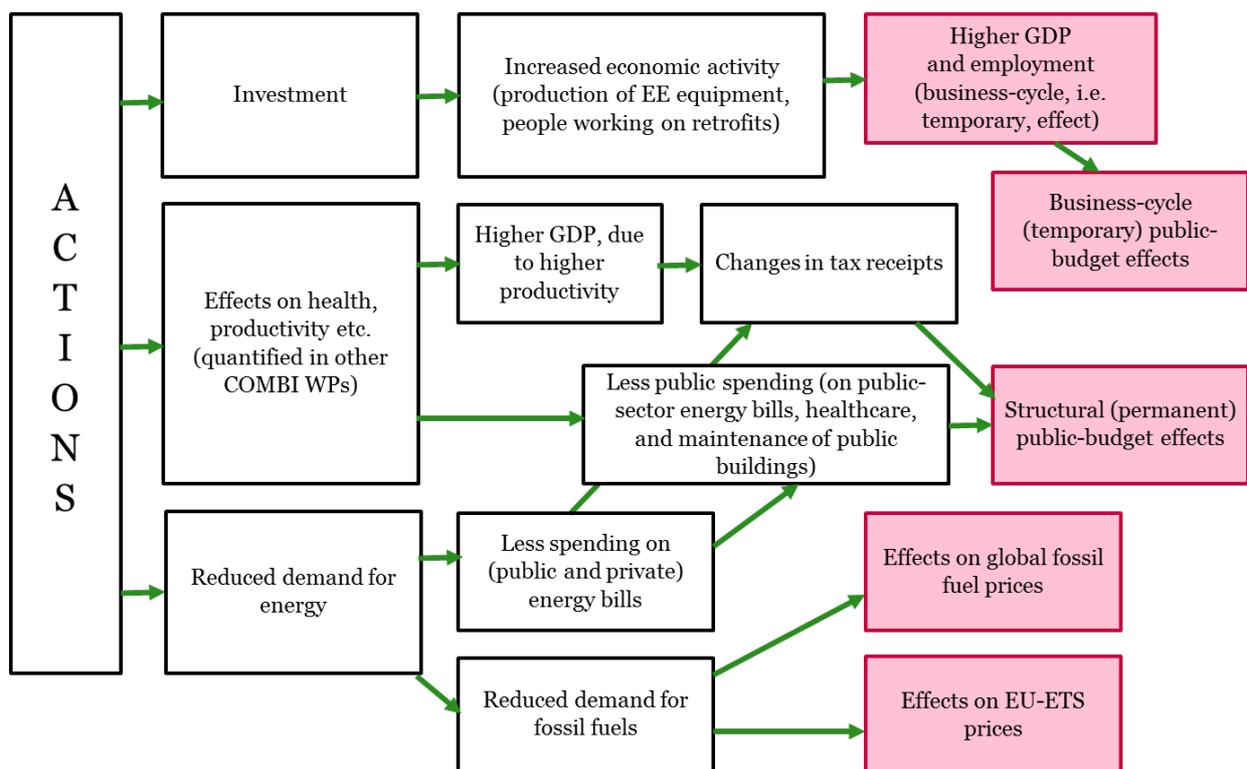


Figure 1 above illustrates the relevant impact pathways for macroeconomic effects. The top row illustrates the business-cycle effects (GDP/employment and public budget), which stem from the initial investments into energy efficiency improvement actions. The bottom part of the figure shows the structural effects on fuel and EU-ETS prices, which result from the reduced energy demand. The (horizontally) middle section of the figure illustrates the different channels by which structural changes to public budgets occur.

### 3.2 Interaction with other impacts

For the business-cycle employment (GDP) impacts, there should be no interactions with other impacts. This is true also for the short-run public budget effects. However, calculating the magnitude of these impacts does require data on the size of initial investment spending needed for each action, which should come out of WP2.

Quantifying the structural public-budget effects relies on estimates of the direct effects (lower energy bills; WP2), as well as any effects that lead to higher structural GDP (higher productivity, e.g. due to health improvements – WP5). In addition, public spending may be affected by other structural impacts, such as spending on healthcare and on renovation of public buildings (WP3, WP5).

Other structural impacts related to energy prices also rely heavily on the direct effects, i.e. the reduced energy demand (WP2).

### 3.3 Rebound effects

There are two types of macroeconomic rebound effect to be considered here.

The business-cycle effects of higher employment and thereby income (GDP) may lead to an increase in energy demanded. This is a pure income effect. Due to the transitory nature of the business-cycle effects, this rebound effect is also transitory.

The structural effects of potentially lower energy prices, as well as potentially lower ETS quota prices, may also induce increases in the amount of energy demanded. These effects stem from price changes, and as such comprise both an income and a substitution effect.

These rebound effects will not be accounted for in a fully integrated fashion within COMBI, as that would require a level of integrated assessment modelling that is outside of the project scope. However, these rebound effects can be assessed and quantified, and checked for consistency with the common rebound approach used in COMBI.

## 4 Approach for impact quantification and monetization

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### 4.1 Preliminary draft impact equation

See section 6 below.

### 4.2 Quantification approach

#### Business-cycle analysis

In COMBI, business-cycle impacts will be quantified using a macroeconomic model of business-cycle fluctuations, which is able to address two main questions:

1. What is the magnitude of the GDP/employment effects that each EEI action can potentially support?
2. To what extent is this GDP/employment boost actually 'additional'?

The first point refers to how investment spending leads to increased economic activity through bringing idle resources into use. This analysis will be carried out in three steps.

- a) Size of the potential for investment spending that relates to each EE improvement action. Data on this should be made available from WP2, ideally by country and action.
- b) Given the investment spending from point (a), what boost to Aggregate Demand does this lead to? This analysis will take into account the labour intensity of each EEI action, as well as to what extent the actions boost domestic economic activity, as opposed to, e.g., importing new capital equipment. The analysis may make use of input-output multipliers to

track the aggregate demand effects across sectors (Input-output tables are available from the World Input-Output Database; see also section 5.2 below).

- c) What are the dynamic effects, i.e. effects over time, of the Aggregate Demand increase under point (b)? This analysis will rely on estimates of demand shock propagations such as in Dalsgaard et al (2001).

The second point stresses that, crucially, investment spending will only be beneficial (in a short-run macroeconomic sense) if the economy is in a situation where the output gap is negative. The mere fact that there is unemployment in the economy does not automatically mean that there is potential for such effects. The analysis must include a rigorous assessment of the size of the output gap over the relevant time period, to identify when, if at all, EEI actions might result in multiple short-run macroeconomic benefits.

To the extent that short-run macroeconomic benefits are present, these are likely to also have a short-run (temporary) effect on the balance of the public budget, e.g., through reduced expenditure on unemployment benefits. This effect will also be quantified, with the use of fiscal multipliers (DG ECFIN 2012; Kilponen et al 2015).

### Structural analysis

Long-run, or structural, macroeconomic effects are unrelated to short-run business-cycle fluctuations, and instead pertain to an economy's properties in equilibrium, or along the long-run growth trend. Energy efficiency improvements may lead to a range of structural effects, including the direct effect of reduced spending on energy consumption, as well as pollution and other health effects, all of which are studied in other parts of COMBI. These effects may again have a (structural, or permanent) effect on public budgets, through less public spending on energy consumption, or reduced health care spending. These effects can be quantified, using the results from other COMBI WPs as inputs, together with data on country-level public spending. Whether such a quantification is feasible is therefore partly contingent on the extent to which other WPs have been able to quantify and monetize the respective effects.

In addition, the EEI actions studied in COMBI are likely to lead to a number of other macroeconomic effects, which are not necessarily benefits, but nonetheless highly interesting. These include

- Effects on global fossil fuel prices (accounting for associated rebound effects)
- Effects on the quota price within the EU-ETS

Such effects can be analysed using a model of aggregate supply and demand for fossil fuels, along with additional analysis of the EU-ETS system.

With respect to the aggregation of impacts, which is coordinated by WP2, it is only the business-cycle effect on GDP/employment, which can be added to the other effects in a straightforward manner. This is within the context of the societal evaluation perspective. All public-budget effects are calculated as part of WP6, and will be aggregated separately, as the public-budget perspective. Structural effects on energy prices will be dealt with as a stand-alone analysis, and cannot be included in any aggregation.

### 4.3 Disaggregation level of MI quantification

Impacts derived for each action will be differentiated across EU countries as follows:

*Business-cycle effects* on employment/GDP: one impact per country and action.

*Public budget effects*: one impact per country and action. This is subject to the level of disaggregation of inputs from other WPs, with respect to structural public-budget effects. These effects include quantified health and productivity impacts, which lead to changes in public spending and tax receipt patterns. If these effects are not available at a country-by-action level of disaggregation, then this will necessarily put a limitation on the disaggregation level possible for structural public-budget effects.

*Other structural effects*: one impact value per action. These impacts relate to changing fossil fuel and ETS quota prices, which are common across EU countries. Differentiating by country is not useful.

### 4.4 Monetization approach

Most macroeconomic impacts are already measured in monetary terms, and as such monetization is generally not needed.

In terms of the business-cycle impacts, the job creation effect is most easily measured as the number of jobs created, but this figure will be derived from the related aggregate demand increase, which reflects the corresponding GDP impact. In other words, the employment effect is directly linked to the corresponding GDP effect, which is monetized already.

## 5 Data

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### 5.1 Use of common WP2 input data

Data needed for the analysis includes:

*Business-cycle effects*:

Investment cost data

*Structural effects*:

Total reduction in energy use, relative to the baseline, by country and action, in TWh or PJ.

In addition, baselines for

- Energy demand
- Global fuel and energy prices
- Electricity generation data (marginal costs and generation mix)

### 5.2 Specific data needs for Macro impacts

*Business-cycle impacts*:

- Jobs per m€ - what is the number of jobs that can be supported with a given level of investment? We will rely on literature estimates when available (e.g. Janssen and Sta-

nasziek (2012) and Mirasgedis et al (2014) for buildings), and also on Eurostat’s structural business statistics.

- Multipliers for the dynamic effects of an Aggregate Demand increase – available from OECD (Dalsgaard et al, 2001)
- The current size of the output gap, and forecast for the near future – from OECD Economic Outlook (2014, 2015)
- Input-Output analysis: I-O tables for all EU countries except Croatia are available from the World Input-Output Database (Timmer et al, 2015)

#### *Public-budget impacts:*

- Fiscal multipliers for EU countries – available from DG ECFIN (2012; also Kilponen et al, 2015)
- Size of public budgets by country (OECD, 2015)
- Energy taxes by country (e.g. Eurostat, 2015)

#### *Structural impacts:*

Copenhagen Economics is currently starting up a project aimed at addressing exactly these issues. We will be able to draw on this work for COMBI, and in particular, the same data sources to map out global supply and demand for fossil fuels.

### 5.3 Data completion methods

Input data needed to perform the *business-cycle analysis* should be available for each EU country, and as such clustering or imputation should not be needed.

In case of data gaps for the analysis of *public-budget effects*, we will be using the values for countries with similar attributes.

## 6 Draft impact equation

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#### *Business-cycle effects*

For the business-cycle GDP effects, the simplified impact equation will look similar to

$$I_{c,a} = (1 - x_{c,a}) \times E_{c,a},$$

Where  $I$  is the impact on GDP,  $E$  is the expenditure on the relevant action, and  $x$  is a measure of the extent to which the expenditure, for the country  $c$  and action  $a$  in question, leads to “exported” aggregate demand. It must be noted that this equation is not the full story, but the impact only arises if there are idle (labour) resources in the economy, i.e. if the output gap is negative. See footnote 3 above, for a clarification of what is meant by ‘idle’ resources.

#### *Public budget effects*

The public-budget effects should not be added together with the other MIs, but should be treated separately (separate perspective).

#### *Structural effects*

These effects cannot easily be written down as an equation, as they are aggregate effects across all EU countries, in a possibly non-linear way. In addition, it seems less useful to consider the

magnitude of these effects by each action, and instead what should be of interest here is the aggregate effect if all actions are undertaken, or perhaps separately for a few groups of actions.

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