BRISKEE

Behavioural Response to Investment Risks in Energy Efficiency

D 4.2 SUMMARY REPORT OF THE RESULTS OF WP4 (MACRO-ECONOMIC MODELLING)

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Content

1 Objective

This report is submitted as deliverable 4.2 in the BRISKEE project in the BRISKEE project and aims at summarizing the methodological, results and policy recommendations derived from the macro-level modelling approach conducted in work package 4.

The BRISKEE project has the objectives of providing evidence-based input to energy efficiency policy-making by investigating the role of household decision-making on three levels:

1) On the micro level, the project provides empirical evidence on the factors that influence investment decisions for energy efficiency technologies in households, in particular focusing on the role of household preferences for time discounting and risk, accounting for possible differences by technologies, household types, and countries.

2) On the meso level, the project explores the impact of time discounting and risk preferences, and the impact of policies affecting those factors on technology diffusion and energy demand in the residential sector in Europe up to 2030. The project uses inputs from the micro-level analysis in order to improve the representation of investment decisions in energy demand modelling tools.

3) On the macro level, BRISKEE explores the long-term macro-economic impacts of changes in micro-economic decision-making and of energy efficiency policy on employment, GDP and exports in the EU up to 2030.

The objective of this report is to summarize the overall findings and policy recommendations following from the macro-level analysis based on the ASTRA macro-model.

Section 2 introduces the methodological approach of the macro-level analysis. Section 3 discusses macro-level results and policy implications. Section 4 presents implications of the results for macro-modellers, including from results from the micro and meso levels.

2 Methodological approach of the macro-level analysis

On the macro level, BRISKEE explores the long-term macroeconomic impacts of changes in micro-economic decision-making and of energy efficiency policy on employment and GDP in the EU up to 2030. The macroeconomic modelling uses input from the scenarios generated in the energy demand models[1].

Accelerating the adoption of energy efficiency technologies and services inevitably affects the whole economy. Structural effects of the impulses resulting from the energy efficiency strategy induce further effects on the macro-economic level.

An energy efficiency strategy induces **positive and negative demand impulses**. On the one hand, increased investments in energy efficiency technologies and services constitute a positive impulse on the economy. On the other hand, the reduction of energy demand leads to reduced demand for the output of the related sectors; they are negative impulses. The effect of differences in magnitude between positive and negative impulses are subject to theoretical discussions between neoclassical oriented economists and Keynesian economists:

- From a neoclassical perspective, additional demand effects are likely if the negative impulses surmount positive impulses, and vice versa. Thus, in the neoclassical tradition, the sum of positive and negative domestic impulses is assumed to be zero. If investments in energy efficiency are higher than reduction in energy demand, other forms of demand (e.g. private consumption) are crowded out to ensure identity of positive and negative impulses. However, there is a different time dimension between positive and negative impulses: investments and associated negative compensation effects take place early, but savings accrue over lifespan of products, so negative impulse and associated positive compensation remains active after the investment period.
- In a more Keynesian flow of arguments, the economy might not be operating at its full production potential. There are various explanations for that, such as price and wage stickiness. Recently, various explanations have been brought forward why the economic crisis has led to extended periods of low interest rates with low inflationary pressure, and demand being lower than supply. Under these assumptions, additional demand can be met without crowding out other forms of demand. In this case, the differential between positive and negative impulses can be met for example by deficit financed public subsidies or by private savings without crowding out effects.

The structural effects of positive and negative demand impulses induce further macro-economic effects, and contribute to a change in the structural composition of the economy. Additionally, the reduction of energy demand lowers the dependence on imported fossil fuels, which has a positive impact on national trade balances. Changes in the structural composition of the economy also contribute to changing imports, and lead to effects on the average labour intensity of the economy. The effects are summarised in Table 1.

The macro-economic effects of the energy efficiency policy scenarios generated in WP 3 of the BRISKEE project are analysed using a three-step methodology (Figure 1).

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1 For more details on the methodology and the results, see Deliverable 4.3: Working Paper On Macroeconomic Modelling

Table 1: Effects resulting from investments and energy cost reductions for consumers of energy efficiency technologies

Effects resulting from investments (positive impulses)	Energy efficiency investments increase demand in sectors providing energy efficiency technologies and services, leading to increased production and employment in these sectors and the upstream sectors related to them. Furthermore, they enhance the chances of domestic producers to increase their technology exports.
Effects resulting from energy cost reductions (negative impulses)	Energy savings reduce spending on energy, leading to reduced production and employment in these sectors, and the upstream sectors related to them.
Effects resulting from compensation of impulse differentials	The differences between investment increases (positive impulses) and energy cost reductions (negative impulses) may affect disposable income and thus consumption in economic sectors not related to energy efficiency. In a neoclassical tradition, it can be assumed that the sum of positive and negative impulses equals zero.
Macro-economic income effects	Changes in production of investment and consumption goods lead to changes in income, which induce further multiplier effects. The impact of these macro-economic effects on sectors differ, and add to changes in the structural composition of the economy induced by the positive and negative impulses.
Effects resulting from changes in the structural composition	The economic sectors differ with regard to import shares and labour intensity. Thus, macro-level changes in the sectorial composition of the economy lead to changes in overall import and labour intensity of an economy.

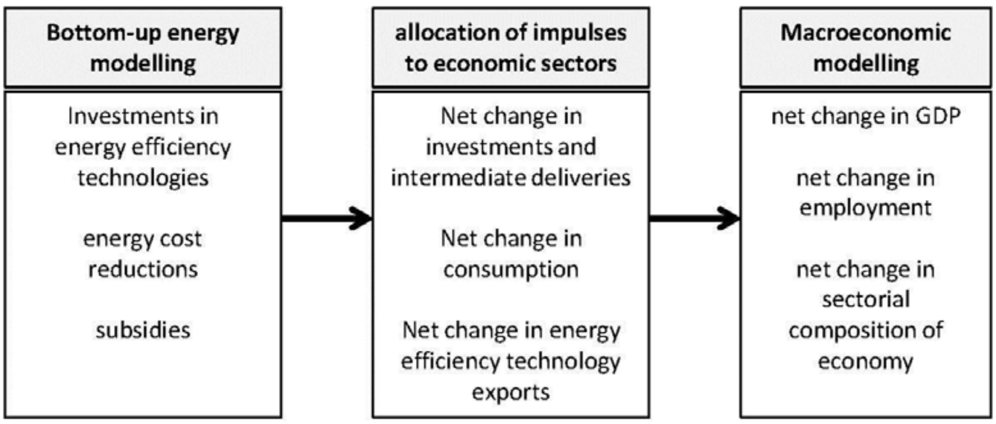

Figure 1: Modelling approach for macro-economic impacts in BRISKEE.

In the first step, the investments and energy cost reductions induced in the scenarios are calculated using a detailed bottom-up modelling approach. In a second step, the investments and savings are allocated to the affected economic sectors. In a third step, the macro-economic impacts are calculated using the dynamic input-output based macro-economic model ASTRA-EC.

Overall, there are a number of positive and negative impulses arising from the penetration of energy efficient technologies (Figure 2). The impulses increase over time, however only slightly after 2025. The new actor-related scenario generally mobilizes higher impulses than the increased policies scenario. In addition to reduced energy demand, negative impulses, which are assumed for compensating the difference between positive investment and negative energy demand impulses, show a considerable volume. Nevertheless, there are two reasons why, in total, the positive impulses slightly exceed the negative ones. First, positive technology exports are not subject to the paradigm of positive impulses equaling negative ones. Second, we assumed that the subsidies from governments to finance energy efficiency also do not fall under the paradigm of positive impulses equaling negative ones. However, this effect is considerable smaller than the compensating effects. Thus, our analysis is more tilted towards neoclassical assumptions.

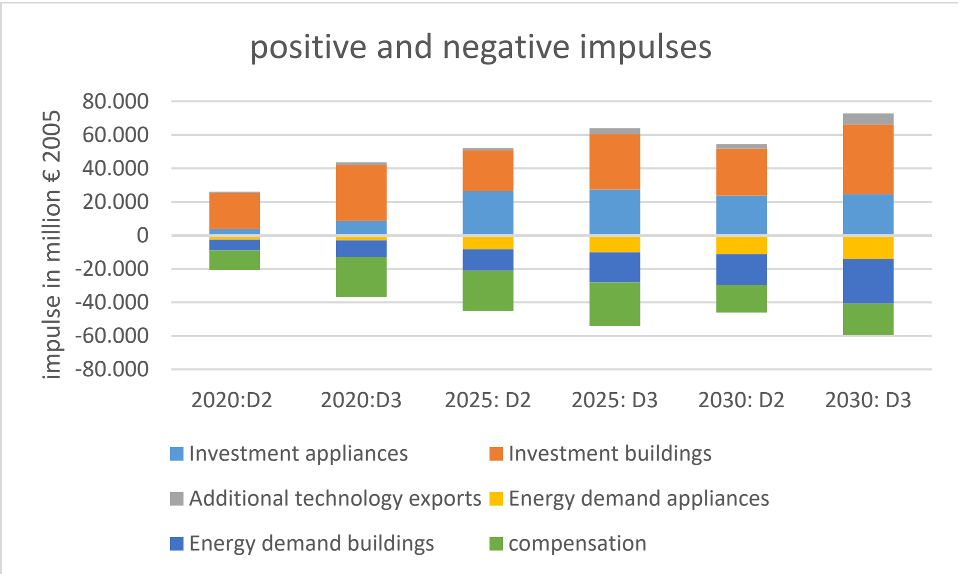

Figure 2: Positive and negative impulses on the EU28 level (Million € 2005)

3 Macro-level results and policy implications

The investment and export impulses have a positive effect on the sectors which provide investment goods in the form of appliances, efficiency technologies and insulation for buildings. The energy demand reduction has a negative effect on the energy sector. Depending on the relationship between the investment impulse and the energy expenditure impulse, a different reaction is supposed for final consumption. If the energy savings are higher than the investment impulse, the saved money is assumed to be spent on other goods, and aggregate consumption thus increases accordingly. If the investments in one country are higher than the associated energy savings, it is assumed that aggregate consumption has to be reduced accordingly. This consumption reduction is alleviated by subsidies, which however increase government expenditures that have to be alimented by the private sector. Thus, from a macro-economic real goods perspective, the spending on energy efficient technologies has an investment character: in the year of the investment, there might be a crowding out of other elements of final demand, if the achieved reduction of energy consumption is not strong enough. However, in the following years, the energy efficiency technologies also lead to energy demand reductions, which enable to spend more on consumption.

Figure 3 illustrates that the overall effect on GDP and employment on the European level is relatively small in both scenarios.

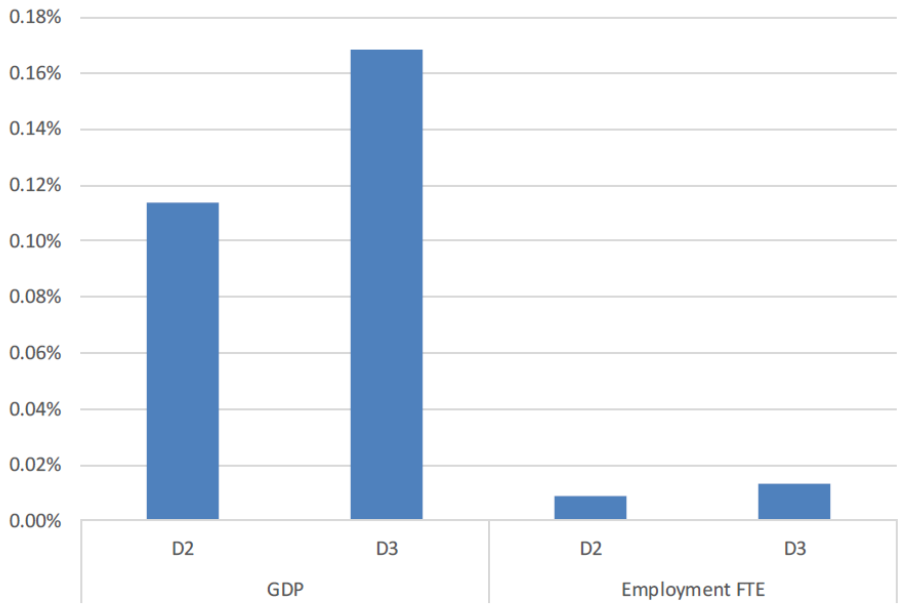

Figure 3: Relative yearly GDP and FTE employment change for EU 28 for the period from 2012-2030 for the increased-policies scenario (D2) and the new actor-related measures scenario (D3), relative to the current-policies scenario

Over the entire simulation period, average EU 28 GDP is 0.11 % above the current-policies scenario in the increased-policies scenario, and 0.17 % above the current-policies scenario in the new actor-related measures scenario. The effects on employment in full time equivalents (FTE) are even smaller: The results point towards an increase of 0.01 % in the increased-policies scenario and 0.013 % in the new actor-related measures scenario. In absolute terms, these changes equate to 17 billion € of additional EU 28 GDP per year in the increased-policies scenario and 25 billion € additional yearly GDP in the new actor-related measures scenario. The yearly changes in European employment are approximately 17.000 additional jobs in FTE in the increased-policies scenario and 26.000 additional jobs in FTE in the new actor-related measures scenario.

The development of the relative GDP change in both scenarios is relatively uniform across the entire simulation period with a small increase in the growth rate towards the end of the simulation period. The yearly change in employment does not increase so uniformly as the GDP change. It reaches a local maximum around 2020, declines slightly and then increases again similarly to GDP towards the end of simulation period.

Taken together, the macro-economic impacts of the scenarios show characteristics of an investment into a modernization process: Investments into energy efficiency technologies have to be offset temporarily by a reduction in consumption. However, the investments drive a structural change, which increases overall macro-economic productivity. This is not mainly due to productivity increases in the investing sector, but via a structural change towards sectors, i.e. the building sector, which is less labour intensive than the service sector[2]. With the push for additional investments ebbing off, and induced energy costs savings lagging behind, consumption is able to pick up in the long run. Differences in the macro-economic effects can be explained by differences in the impulses and differences in the structural composition of the economy, which are expressed as differences in the labour intensity and value chains of the sectors affected by the economic changes.

A comparison with the results of other studies shows some similarities, but also some differences. Similar to these studies, we see positive, albeit modest positive economic impacts, which are driven by import substitution of energy carriers. Differences arise with regard to the sectoral composition. Here we see that some services might be also among the sectors losing employment. This is due to, among other things, the effects that the positive impulses (higher investments in energy efficiency) mainly accrue to manufacturing sectors. On the other hand, the effects of a reduced consumption, which are necessary to compensate for the difference between positive and negative impulses, mainly accrue to service sectors. Due to the higher labour intensity of services, it is therefore not surprising to see that in our results – in contrast to some other studies – the employment impacts are less strong than the GDP impacts, at least during the period, until which investments lead to more negative impulses for consumption. Our assumption that crowding out effects are (temporarily) taking place contributes substantially to these differences.

There are various caveats which have to be taken into account in interpreting these results. First, the positive effects of energy costs reductions cannot fully be accounted for within the time framework chosen (i.e. up to 2030), because they are lagging behind the investments. Second, the results depend on the results of the energy demand modelling, and especially on the order of magnitude of investments in relation to energy cost reductions. Third, as mentioned above, the results are influenced by our assumption that crowding out of private consumption is prevailing in the compensation of positive impulses exceeding negative ones. **This is a rather cautious, neoclassical assumption.** If a more Keynesian situation were assumed, in which underutilized capacity and idle capital can accommodate additional investments, **the assumption of a strong crowding out of consumption by investment would not hold anymore**. Under such assumptions, the additional investments lead to increase in a final demand impulse, which leads via multiplier effects to a higher increase in employment and GDP than is depicted in our model run. **Taken together, this means that our results are not on the optimistic side of possible outcomes. They should be interpreted as a robust outcome, which shows that investments in energy efficiency will have at least modest positive economic impacts for the EU**.

The main recommendations from this analysis is therefore that **macro-economic impacts need to be carefully investigated in their dynamic dimension between short term and longer term impacts and structural shifts**. It is a policy decision and societal debate how these dynamic impacts can be made acceptable in view of long-term benefits. This could imply "exnovation" strategies for actors which will strongly loose in the structural changes.

[2] It is argued that energy efficiency measures spur investments in particular in the building sector which are more labour-intensive than energy supplying sectors. This is indeed the case and in the long-run, when investments are paid, this triggers positive impulses for the economy. However, under the above assumption of positve and negative impulses compensating each other, until investments have returned, the loss in consumption in the service sector, which is more labour-intensive than the building sector, leads to this observation.

4 Implications of results for macro-modellers

The caveats pointed out in the previous sections also lead to important conclusions for future macro-modelling. The first conclusion relates to the time horizon of scenario building. In energy scenario modelling, the direct effects of energy technology diffusion on energy demand and emissions, and related costs, are of primary concern. Thus, typically a time horizon is chosen which reflects the effect of the last technology coming into the market. Thus, in the BRISKEE project, modelling of the scenarios spans until 2030. However, in the logic of macro-economic modelling, the impulses of the strategy span until the last technology exits the market. The (negative) impulses only cease after this point in time. Thus, a simulation of macro-economic effects of energy efficiency which covers all effects over time requires energy scenarios as input which span the complete time horizon until the phasing out of the last newly introduced technology. Once the investments are paid off, more money is available from the avoided energy imports, which can then be spent on domestic consumption. This would then lead to positive effects on GDP and employment.

A second issue relates to the assumptions made with regard to compensation of differences between positive and negative impulses. Depending on the outlook on the persistence of a lack in demand, the importance to model the effects in a more Keynesian mode might increase. With lower negative impulses, modelling results would yield more positive effects on GDP and employment.

A third issue relates to the spending behaviour of private households. Following a more neoclassical approach, we have modelled a crowding out based on macro-economic considerations, and there was no rational to differentiate between increased-policies scenario and new actor-related measures scenario. However, if we assume a stronger role of Keynesian assumptions, microeconomic considerations in financing decisions might become more important. Under these assumptions, it might make a difference on aggregate demand whether the households decide to finance efficiency investments out of savings or credits, or out of reduced spending on other consumption goods. In that case, we have to ask whether or not the differences with regard to discount rates, as arising from the investigations carried out at the micro-level, also influence the microeconomic perspective of the actors involved with regard to financing and spending decisions.

The results on economic effects of energy efficiency also open up **new avenues for modelling feedbacks between outcomes of policies and behaviour**. Our innovative modelling approach in BRISKEE linked a macro-economic model with the energy systems models (Figure 4). Typically, these models take the socio-structural environment as given. In general, norm activation, motivation and behavioural patterns are taken as given in economic analysis. In the BRISKEE project, we have added an explicit step in focusing on the role of household preferences for time discounting and risk, accounting for possible differences by technologies, household types, and countries. However, various psychological theories and research perspectives focus on **how behavioural outcomes can lead to redefinition of determinants and adjustments in future behaviour**. Using such an integrated framework for explaining environmental behaviour, there are various feedbacks which are not accounted for in today's analysis. This requires to move forward with a new highly ambitious modelling approach, which not only links bottom-up technology models to macro-economic models, but goes even further by integrating dynamic psychological models of behavioural change as well.

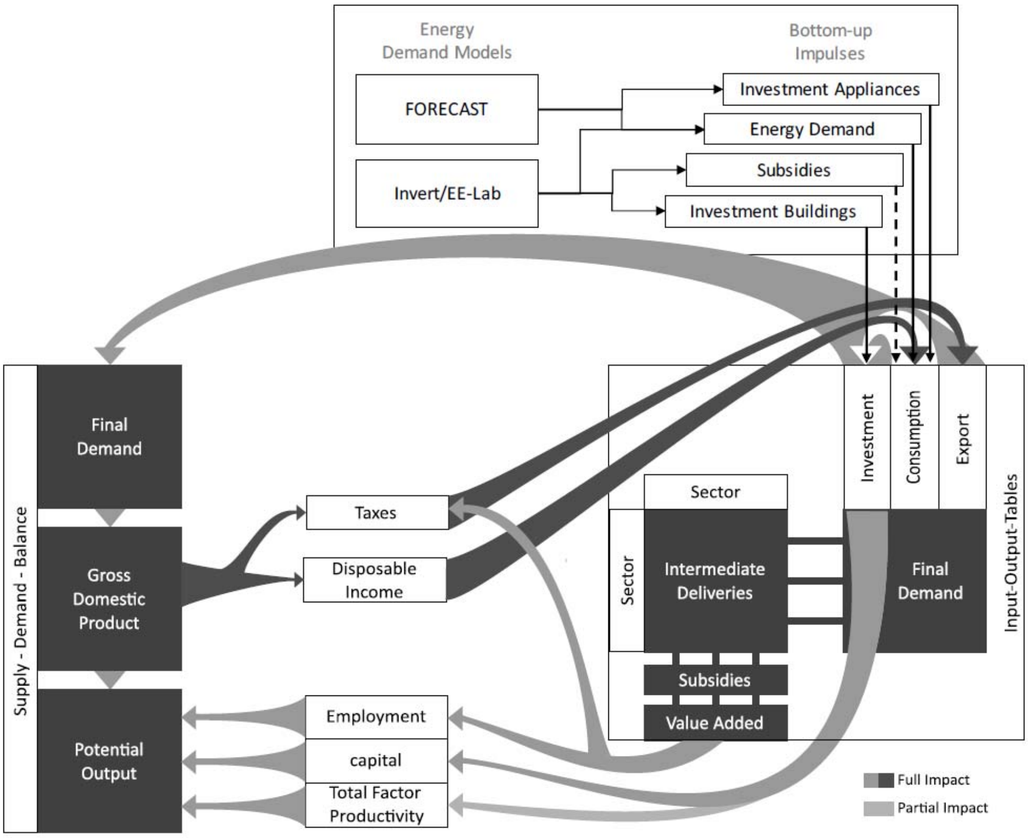

Figure 4: Macro-economic modelling logic in ASTRA-EC

5 Literature

BRISKEE (2017). Deliverable 4.3: Working Paper On Macroeconomic Modelling. Available at www.briskee.eu