BRISKEE

Behavioural Response to Investment Risks in Energy Efficiency

D 4.1 INPUT TO MACROECONOMIC MODELLING

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Content

1 Objective of the report

This report is submitted as deliverable 4.1 in the BRISKEE project. The report presents the methodological approach used in BRISKEE for modelling the macroeconomic effects of energy efficiency improvements in the EU-28. Furthermore, it summarizes the macroeconomic impulses generated from the energy demand projections conducted in BRISKEE WP 3.

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 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 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.

2 Methodological approach

This section describes the methodological approach that is applied in the BRISKEE project for transferring the results from the energy demand modelling (WP 3) into the inputs for the macroeconomic model ASTRA (WP 4). The description follows Hartwig et. al. (2017).

2.1 Characterization of macroeconomic effects of energy efficiency measures

Accelerating the adoption of energy efficiency technologies and services inevitably affects the whole economy through the following two main effects (IEA 2014): On the one hand, macroeconomic effects result from increased investments in energy efficiency technologies and services. On the other hand, energy cost reductions arising from the reduction of energy demand increase disposable income and thus induce further macroeconomic effects. Additionally, the reduction of energy demand lowers the dependence on imported fossil fuels, which has a positive impact on national trade balances. These effects are described in Table 1 for energy consumers and for producers of energy efficiency technology.

Table 1: Effects resulting from investments and energy cost reductions for consumers of energy efficiency technologies (Hartwig et. al 2017)

Effects resulting from investments	Energy efficiency investments increase demand in sectors providing energy efficiency technologies and services, leading to increased production and employment in these sectors. At the same time, investments may reduce disposable income and thus consumption in economic sectors not related to energy efficiency.
Effects resulting from energy cost reductions	Energy savings reduce spending on energy and increase the disposable income and presumably the consumption in other sectors. The increased consumption induces economic activity in these sectors.

Estimating the macroeconomic effects of energy efficiency policy requires a detailed understanding of how the policy measures act on the micro level. For example, policy measures that address investments in thermal insulation have an effect (among others) on the construction sector, whereas product policy measures have an impact on the sectors that produce such products. It is therefore necessary to evaluate the projected energy savings at a technologically detailed level. The methodological approach applied in the BRISKEE project creates a coupling between the detailed bottom-up energy demand models Invert/EE-Lab (for buildings) and FORECAST (for appliances) with the macroeconomic system dynamics model ASTRA-EC. The coupling approach combines technology-based engineering knowledge in the relevant energy-using sectors with a macroeconomic perspective by taking advantage of the detailed data on technologies in the energy demand models, and of the dynamic input-output structure in the macroeconomic model. The approach therefore addresses one of the shortcomings of macroeconomic modelling, which generally represents sector details, but does not support technology details (IEA, 2014).

2.2 Methodological approach

The macroeconomic effects of the energy efficiency policy scenarios generated in WP 3 of the BRISKEE project are analysed using a three-step methodology (see Figure 1). 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 macroeconomic impacts are calculated using the dynamic input-output based macroeconomic model ASTRA-EC. The methodological approaches that are applied in each of the three steps are outlined in the following subsections.

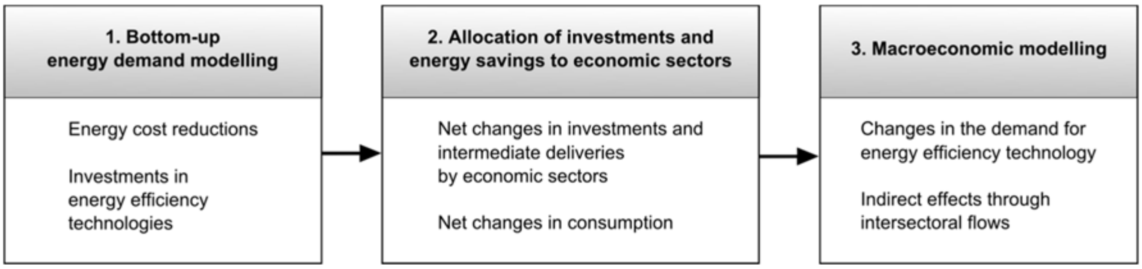

Figure 1: Methodological approach (Source: Hartwig et. al 2017)

2.2.1 Bottom-up energy demand projections (step 1)

The data on energy demand and investments are based on the scenarios presented in D 3.1 of the BRISKEE project, where energy demand projections are provided using bottom-up simulation models that capture the diffusion of energy efficiency technologies. The energy demand modelling platform FORECAST[1] is used for projecting the energy demand of residential appliances. The modelling platform Invert/EE-Lab [2] is used for projecting the energy demand for buildings.

The energy demand models include a detailed technology database and use a logit approach for modelling decision-making including observed barriers and heterogeneous expectations among decision makers (households or companies). The modelling approaches for the three policy scenarios include a mix of policy measures to support an accelerated diffusion of energy efficiency technologies, including minimum efficiency requirements and standardization, taxes, subsidies and a range of information-based measures (for details see BRISKEE D 3.4, forthcoming).

2.2.2 Allocation of investments and savings to economic sectors in input output tables (Step 2)

In order to transfer the outputs of the bottom-up modelling to the macroeconomic model ASTRA-EC, the changes in investments, consumption, energy demand and subsidies are allocated to the economic sector classification of the Input-Output tables used in ASTRA-EC. In the bottom up

1 www.forecast-model.eu
2 www.invert.at

models, investments and energy savings are calculated considering individual energy efficiency measures and are not necessarily in the same sectoral classification as the economic sectors in the Input-Output tables. For each energy efficiency measure, it is therefore necessary to allocate the results from step 1 to the economic sectors of the Input-Output-tables. Furthermore, it is necessary to determine the sectoral splits of the changes in the consumption bundle. The following sections outline how the results are transformed for residential appliances and residential buildings.

Residential appliances

For residential appliances, the macroeconomic effects are driven by the (individual) investments in energy efficient appliances undertaken by consumers (whose investments are treated as consumption in national accounting, except for investments in the building infrastructure – see following section) and the energy cost reduction for consumers. Both the investments and the energy cost reductions are included in the consumption vector, where the investments lead to increased consumption in sectors producing energy efficient residential appliances. The energy cost reduction leads to decreased consumption in the electricity-providing sector. The consumption changes are not simply additive; they are multiplied by sectoral elasticities and overall consumption shares are re-normalised, so that there is no aggregate consumption change. This distinction is important since we do not assume that bottom-up policies change the marginal propensity to consume.

Residential Buildings

For buildings, deriving the inputs for the macroeconomic modelling is more complex due to the variety of efficiency technologies, investors, financing mechanisms and the landlord-tenant structure. The energy efficiency technologies can be split up into two broad categories: building envelope (i.e. thermal retrofits) and heating, ventilation and air conditioning (HVAC) technologies. The HVAC technologies are further split up into the following types:

1. Fossil
2. Biomass
3. Heat pumps
4. District Heating
5. Electric Heating
6. Solar Thermal

In addition to different technologies, different constellations of landlords and tenants (private households and companies) should be considered in macroeconomic analyses if the respective information is available.

The energy efficiency investments of **private home owners** enter the input-output module of the macroeconomic model through the investment vector, where the elements corresponding to the sectors producing the efficiency technologies and providing services related to the installation of these technologies increase. As stated in the previous section, private households' expenditures are entirely contained in the consumption vector with the exception of investments in the building infrastructure, which are portrayed by the investment vector. The resulting energy savings, on the other hand, are portrayed by a decrease in the element of the consumption vector corresponding to the energy sector. The investments in thermal retrofits and efficient HVAC technologies are typically financed through varying combinations of subsidies, credits, and private capital. In the case of subsidies received by private households, government expenditures are modelled to rise. Credit financing increases the consumption vector element corresponding to the financial sector. The reduced savings level and the increased value of the buildings are not considered in the model (see also Table 2).

Energy efficiency investments of **private landlords** are also represented by increasing the investment vector elements corresponding to the sectors producing the efficiency technologies and credit services. The energy cost reduction of the tenant is represented by decreasing the element of the consumption vector corresponding to the energy sector. The financing of private landlords' investments is portrayed in the same way as that of private home owners.[3] Similar to the case of residential appliances, the investments in HVAC technologies and corresponding energy savings do not lead to a change in aggregate final demand but merely a shift between consumption purposes (see also Table 2).

Commercial landlords for residential buildings: even though a fraction of the residential buildings are owned by companies, housing associations or housing cooperatives (in Germany, about 35 % of all rented properties), this distinction is not made in the BRISKEE project due to a lack of data. Energy efficiency investments of the housing industry and residential building cooperatives would also be represented by increasing the element of the investment vector that corresponds to the sectors producing efficiency technologies as well as related services. The energy savings of the tenant (private household) would be represented by decreasing the value of the consumption vector element corresponding to the energy sector, analogous to tenants of private landlords. Also analogous to private landlords, the energy efficiency investments are typically financed through varying combinations of subsidies, credits, and retained earnings. The difference between private and commercial landlords therefore only lies in a slightly differing portrayal of investments and subsidies, which is assumed not to have a large influence on the aggregated macroeconomic effects.

Table 2: Macroeconomic impulses from energy efficiency measures for buildings

	Drivers for macroeconomic effects	**Representation in macroeconomic model**	**Relevant sectors**	**Effects**
Private home owners and private landlords	Investments	Investment vector	Minerals, chemicals, metal products, industrial machines, electronics, plastics, construction, other market services	Increase
	Energy savings	Consumption vector	Energy	Decrease
	Financing	Consumption vector	Banking and insurance	Increase

2.2.3 Macroeconomic modelling (Step 3)

The macroeconomic model ASTRA-EC is at the core of the BRISKEE macroeconomic analysis. ASTRA-EC is based on the System Dynamics methodology and emphasizes dynamic interactions, the integration of differences in short- and long-run effects and an explicit modelling of supply-side restrictions. The model contains 25 economic sectors and uses the time span from 1995 to 2013 for calibration. The model equations are empirically evaluated and, as a result of econometrically estimated equations, the agents in the model are myopic and thus the model philosophy employs the concept of bounded rationality.

[3] In Germany, it is possible to pass on the costs of the energy efficiency investments to the tenants through an 11% increase of the rent (§559 of the German civil code). However, not all EU countries have such schemes in place and little data is available on whether landlords actually make use of this clause.

Figure 2 provides a schematic illustration of the modelling logic of ASTRA-EC and shows how the main policy impacts derived from the energy demand models flow into the macroeconomic modelling. As outlined in the previous section, the energy efficiency measures covered in the energy demand models lead to changes in investments (e.g. investments in energy efficiency technologies) and consumption (e.g. reduced energy demand). As indicated in *Figure 2*, these bottom-up impulses are integrated in ASTRA-EC mainly by changing the investment demand and consumption vectors. Consumption (together with investment, government expenditures and exports) forms the second quadrant of input-output tables, which is equivalent to final demand when imports are subtracted. Final demand represents the demand side of the economy. It is complemented by the supply side, which is fed by capital, labour and technological progress, representing the production potential of the economy. Gross Domestic Product (GDP) is derived by balancing both the supply and the demand sides of the economy. GDP growth initiates further growth in consumption, triggering investments to meet this new consumption demand (white arrow in *Figure 2*). These feedback effects between GDP, income, consumption, investments and again GDP are a key feature of ASTRA-EC and allow for the modelling of induced effects of the implementation of energy efficiency measures. Taking into account these induced effects is particularly important when modelling the long-term macroeconomic effects of energy efficiency policy. A more detailed description of ASTRA-EC can be found in the Appendix.

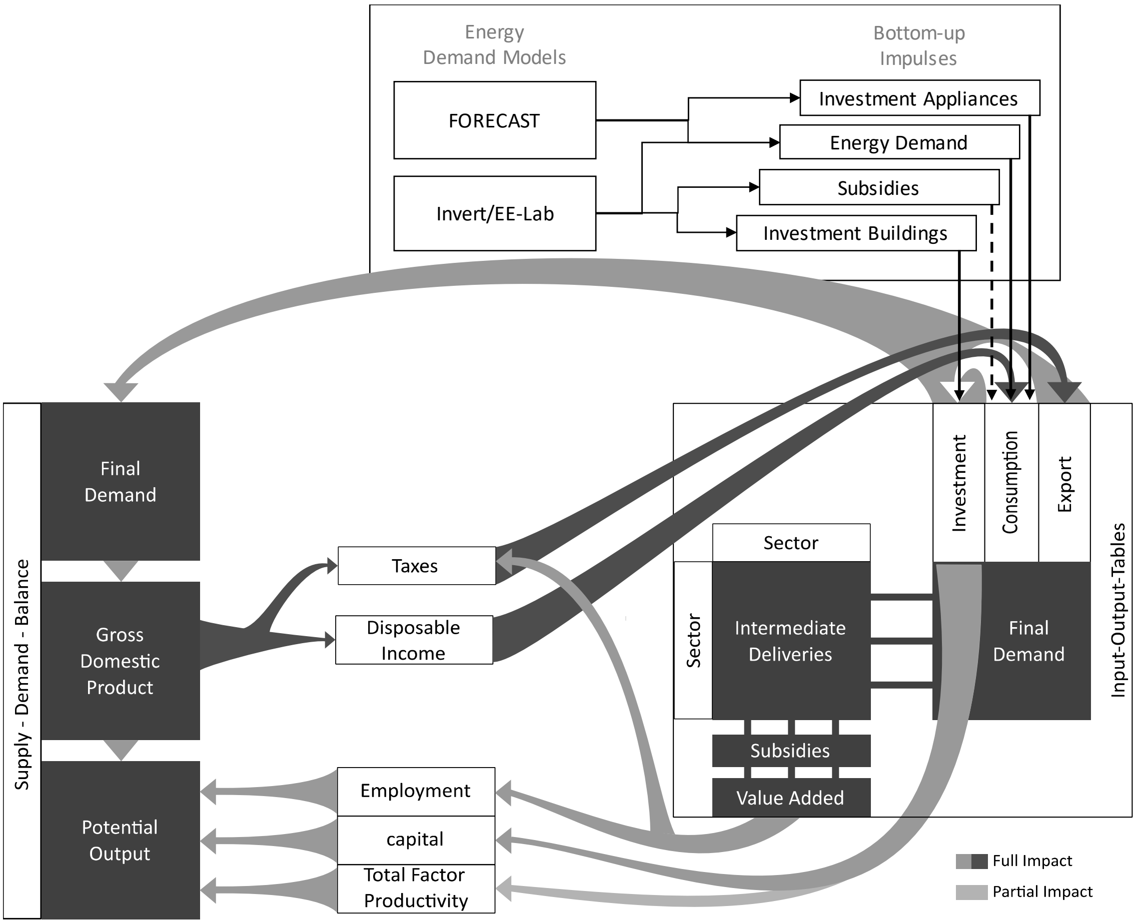

Figure 2: Macro-economic modelling logic in ASTRA-EC. Source: own illustration, numbers explained in the following paragraph

The impulses derived from the bottom-up energy demand models are implemented in ASTRA-EC in the following manner (cf. *Figure 2*):

- Consumption changes due to investments in appliances are implemented as relative changes to the baseline scenario in the consumption vector without changing overall consumption. This affects the elements of the consumption vector corresponding to the sectors producing energy efficient appliances (see also section 3.2.1).
- Investment changes due to investments in efficient heating technologies for buildings are implemented as relative changes to the baseline scenario in the investment vector without changing the overall level of final demand. The changes in the investment vector apply to sectors that produce energy efficient building technologies (see also sections 3.2.2 and 3.2.3).
- In private households, energy is regarded as an ordinary consumption good and a reduction of energy demand is applied as a reduction in the consumption vector. The only affected sector is the energy sector (see also section 3.2.4).
- Subsidies are applied to the government sector and thus change government consumption and the government budget (see also section 3.2.5). The positive consumption impulse counteracts the consumption normalisation outlined in section 2.2.2 by re-increasing overall consumption at the level of the subsidies. However, higher government expenditures that are not financed through government revenue may induce a crowding out effect due to government borrowing.

These impulses not only directly affect the sectors producing appliances and efficiency technologies for buildings but also indirectly affect other sectors through the interconnectedness of the economy. The reduction in energy demand also indirectly leads to reductions in energy imports. In addition, the changes in consumption induce further macroeconomic effects, including a change in aggregate value added (GDP), leading to subsequent changes in the overall investment volume, employment and productivity. Therefore, the production potential of the economy may change as a result of the energy efficiency measures.

3 Macroeconomic impulses in the BRISKEE project

3.1 Output from energy demand models

This section presents the output from the energy demand models in an aggregated form on a country level. The more detailed output of the models for different technologies is shown with more detail in the sections 3.1.1.3 for appliances and 3.1.2.3 for buildings for one sample country.

3.1.1 Appliances

This section presents the outputs from the energy demand model FORECAST for appliance and lighting technologies, e.g. refrigerators, washing machines, lighting and televisions.

3.1.1.1 Investments

The following table shows the differences of investments to appliance and lighting technologies as the differences between the increased-policies scenario or the new actor-related policies scenario and the current-policy scenario.

Table 3: Overview of differences of investments in appliance and lighting technologies in Mio EUR, difference (D2) between increased-policies scenario and current-policy scenario, difference (D3) between new actor-related policies scenario and current-policy scenario

	2020		2025		2030	
Country/scenario	**D2**	**D3**	**D2**	**D3**	**D2**	**D3**
Austria	44.5	111.1	387.4	392.7	355.8	360.2
Belgium	94.0	215.9	718.3	743.6	645.8	670.7
Bulgaria	57.3	98.7	223.0	223.8	229.4	230.5
Croatia	72.0	143.5	328.2	336.7	310.0	318.2
Cyprus	13.0	20.3	46.6	48.3	41.8	43.3
Czech Republic	29.6	65.6	218.6	227.2	202.7	210.6
Denmark	33.7	95.5	460.3	470.9	385.6	394.4
Estonia	11.4	17.5	56.1	56.4	46.3	46.8
Finland	35.1	85.6	426.9	433.7	372.3	379.1
France	460.9	1114.9	3959.8	4086.4	3499.9	3623.3
Germany	255.3	956.0	3736.4	3885.3	3075.6	3235.0
Greece	151.1	227.1	462.2	482.0	413.7	431.8
Hungary	44.8	72.3	193.1	196.0	185.3	188.6
Ireland	75.5	123.3	290.6	298.5	287.6	295.2
Italy	999.9	1993.5	4558.2	4676.3	4305.5	4419.9
Latvia	8.2	14.1	31.4	31.0	30.1	29.7
Lithuania	13.8	21.8	46.2	45.8	42.3	41.9

Luxembourg	4.6	9.0	32.8	33.2	32.7	33.0
Malta	5.8	8.6	21.3	22.3	18.9	19.7
Netherlands	109.5	305.7	1159.8	1196.2	1062.6	1098.1
Poland	96.5	215.8	776.2	783.9	688.8	695.3
Portugal	90.6	173.5	445.1	463.9	375.0	391.0
Romania	155.2	258.4	737.0	740.9	619.3	622.0
Slovakia	11.8	25.0	81.9	83.2	73.9	75.7
Slovenia	15.8	47.3	137.0	141.2	118.3	122.8
Spain	690.7	1038.2	2003.8	2078.9	1888.1	1956.7
Sweden	64.4	165.1	827.7	841.6	734.8	747.5
United Kingdom	297.5	1031.8	4184.5	4280.1	3642.5	3738.7

3.1.1.2 Energy costs

The following table shows the differences of energy costs for appliance and lighting technologies as the differences between the increased-policies scenario or the new actor-related policies scenario and the current-policy scenario.

Table 4: Overview of differences of energy costs for appliance and lighting technologies in Mio EUR, difference (D2) between increased-policies scenario and current-policy scenario, difference (D3) between new actor-related policies scenario and current-policy scenario

	2020		**2025**		**2030**	
Country/scenario	**D2**	**D3**	**D2**	**D3**	**D2**	**D3**
Austria	-49.0	-57.8	-151.3	-180.2	-197.9	-241.5
Belgium	-66.0	-74.8	-189.5	-219.6	-249.7	-298.8
Bulgaria	-7.6	-10.0	-31.7	-40.7	-54.7	-69.9
Croatia	-11.1	-13.5	-47.6	-57.0	-75.5	-90.5
Cyprus	-5.5	-6.7	-15.0	-18.7	-18.5	-24.4
Czech Republic	-19.7	-22.1	-63.9	-73.2	-83.7	-96.4
Denmark	-61.6	-67.6	-171.8	-191.5	-177.0	-203.3
Estonia	-7.9	-8.1	-16.8	-17.6	-14.7	-15.8
Finland	-57.4	-58.9	-129.8	-134.0	-92.6	-99.2
France	-273.3	-343.2	-903.4	-1135.5	-1231.5	-1573.3
Germany	-615.8	-791.0	-2501.0	-3167.6	-3825.5	-4890.1
Greece	-61.8	-75.4	-168.3	-210.7	-220.6	-290.2
Hungary	-15.8	-17.3	-51.2	-56.2	-62.1	-69.2
Ireland	-59.1	-62.1	-131.0	-140.6	-113.4	-127.7
Italy	-153.5	-187.8	-661.0	-792.3	-1048.5	-1256.9
Latvia	-3.7	-4.1	-11.0	-12.4	-14.3	-16.4
Lithuania	-7.1	-8.4	-19.0	-22.3	-25.1	-30.6
Luxembourg	-1.4	-1.8	-7.0	-8.3	-12.3	-14.5
Malta	-0.9	-0.9	-2.3	-2.5	-2.7	-3.0

Netherlands	-106.8	-122.6	-310.1	-362.5	-401.2	-486.1
Poland	-28.2	-36.8	-147.5	-178.6	-259.2	-309.8
Portugal	-37.3	-41.3	-112.4	-126.4	-126.0	-144.5
Romania	-36.7	-43.7	-115.2	-136.5	-156.5	-188.7
Slovakia	-11.8	-14.4	-31.1	-38.4	-45.2	-57.0
Slovenia	-7.4	-8.8	-17.7	-21.8	-23.3	-29.8
Spain	-186.2	-245.9	-614.3	-804.5	-903.7	-1210.2
Sweden	-131.3	-149.7	-348.1	-401.0	-383.0	-459.7
United Kingdom	-577.0	-635.5	-1479.4	-1664.3	-1548.5	-1814.7

3.1.1.3 Detailed output for a sample country

The aggregated output from the energy demand models presented in the previous sections gives an overview of the input to the macroeconomic model ASTRA-EC. The input to ASTRA-EC, however, are more detailed meso-level results, which are illustrated for the country of France in this section. Similar results contributed to the inputs to the macroeconomic modelling of the other countries.

Table 5: Overview of differences of investments by technology in Mio EUR for France, difference (D2) between increased-policies scenario and current-policy scenario, difference (D3) between new actor-related policies scenario and current-policy scenario

	2020		2025		2030	
Technology/scenario	**D2**	**D3**	**D2**	**D3**	**D2**	**D3**
Refrigerators	384.5	511.8	1124.9	1125.7	977.1	977.6
Freezers	0.0	195.9	756.9	758.5	911.4	913.3
Washing machines	3.3	87.7	140.4	240.6	46.4	144.7
Dryers	65.5	103.3	549.6	566.2	328.1	342.1
Dishwashers	0.0	198.9	1319.1	1320.5	1035.2	1036.3
Modelled ICT[4]	132.3	140.7	139.1	143.7	201.7	207.6

Table 6: Overview of differences of energy costs by technology in Mio EUR for France, difference (D2) between increased-policies scenario and current-policy scenario, difference (D3) between new actor-related policies scenario and current-policy scenario

	2020		2025		2030	
Technology/scenario	**D2**	**D3**	**D2**	**D3**	**D2**	**D3**
Refrigerators	-28.4	-36.7	-134.8	-154.9	-239.5	-264.1
Freezers	-8.1	-16.0	-68.3	-82.7	-147.8	-165.4
Washing machines	-12.3	-17.0	-56.1	-71.0	-69.4	-93.6

4 The modelled end-uses of information and communication technologies (ICT) include televisions, computer screens, desktop computers, laptop computers, routers and set-top boxes. Other end-uses such as small electric appliances or chargers for phones and tablet computers are summarized in the category "New & other end-uses".

Dryers	-22.8	-29.4	-145.4	-160.0	-198.8	-219.5
Dishwashers	-7.1	-9.5	-40.4	-48.8	-70.2	-80.9
Modelled ICT[5]	-2.1	-3.4	-7.1	-8.3	-11.0	-10.0

3.1.2 Buildings

This section presents the data input from the energy demand model Invert/EE-Lab to the macroeconomic model ASTRA-EC. The data exchange focuses on differences in costs and spending on energy carriers and investments into heating systems as well as thermal renovation measures. Please also see the summary report of WP3 for details on energy demand developments in the building sector for building technologies, e.g. heating systems and insulation.

3.1.2.1 Investments

The following table shows the differences of investments in building technologies as the differences between the increased-policies scenario or the new actor-related policies scenario and the current-policy scenario. The investments include investments into heating systems as well as investments in thermal retrofit measures (excluding maintenance measures without efficiency improvements).

Table 7: Overview of differences of investments in building technologies (heating systems and thermal retrofits) in Mio EUR, difference (D2) between increased-policies scenario and current-policy scenario, difference (D3) between new actor-related policies scenario and current-policy scenario

	2020		2025		2030	
Country/scenario	**D2**	**D3**	**D2**	**D3**	**D2**	**D3**
Austria	46.0	145.8	63.3	288.0	63.7	215.1
Belgium	349.6	605.0	465.0	574.3	254.5	410.7
Bulgaria	212.8	352.1	247.7	404.2	319.3	440.4
Croatia	11.6	185.0	38.7	235.4	50.2	281.1
Cyprus	18.9	30.1	25.5	44.0	25.8	48.0
Czech Republic	315.0	544.3	422.7	780.4	695.5	983.1
Denmark	-73.7	18.8	7.4	133.2	-17.8	163.0
Estonia	56.8	93.3	74.9	105.2	57.9	99.8
Finland	29.6	553.8	37.9	550.8	113.7	565.9
France	5196.8	7587.6	4791.8	7349.4	5140.7	9275.9
Germany	6493.3	7040.0	6272.5	5087.3	6732.4	8062.0
Greece	1030.3	1298.9	753.3	854.5	33.5	389.5

[5] The modelled end-uses of information and communication technologies (ICT) include televisions, computer screens, desktop computers, laptop computers, routers and set-top boxes. Other end-uses such as small electric appliances or chargers for phones and tablet computers are summarized in the category "New & other end-uses".

Hungary	0.0	28.7	85.3	202.2	-45.2	272.1
Ireland	261.8	343.8	341.8	489.1	448.4	567.5
Italy	541.5	4673.4	1633.3	4304.7	2445.9	4600.2
Latvia	-16.0	10.7	-18.9	24.1	-23.1	24.8
Lithuania	38.0	90.2	44.7	106.1	56.4	125.3
Luxembourg	-3.8	3.1	7.8	18.3	1.3	29.2
Malta	15.1	19.3	22.3	24.4	20.4	26.1
Netherlands	196.6	660.5	68.8	578.2	151.8	425.9
Poland	2431.3	2546.1	3013.5	2721.5	3279.8	3462.5
Portugal	331.1	314.0	144.3	160.9	132.9	222.4
Romania	56.9	418.1	7.1	357.7	-5.4	457.4
Slovakia	3.4	60.5	11.6	55.2	27.6	72.2
Slovenia	266.5	350.7	249.1	300.9	176.5	271.0
Spain	-146.9	-266.9	-156.6	77.1	229.3	656.2
Sweden	97.1	396.6	149.3	508.9	295.6	547.5
United Kingdom	3662.2	5260.2	5268.5	6711.1	7358.1	9044.9

3.1.2.2 Energy costs

The following table shows the differences of energy costs for building technologies as the differences between the increased-policies scenario or the new actor-related policies scenario and the current-policy scenario.

Table 8: Overview of differences of energy costs for building technologies in Mio EUR, difference (D2) between increased-policies scenario and current-policy scenario, difference (D3) between new actor-related policies scenario and current-policy scenario

	2020		2025		2030	
Country/scenario	**D2**	**D3**	**D2**	**D3**	**D2**	**D3**
Austria	134.4	109.3	-155.0	-205.8	-276.7	-348.6
Belgium	-98.2	-149.8	-217.1	-335.8	-244.1	-476.3
Bulgaria	-54.0	-116.7	-146.4	-255.0	-267.1	-418.0
Croatia	0.9	-64.8	-13.6	-139.1	-40.7	-216.8
Cyprus	-0.9	-3.8	-2.9	-6.8	-4.5	-10.7
Czech Republic	-137.0	-245.7	-462.3	-641.2	-825.9	-1098.3
Denmark	-335.0	-379.9	-288.4	-399.5	-332.1	-538.7
Estonia	-7.9	-14.0	-17.1	-27.0	-25.2	-38.7
Finland	-14.9	-42.7	-24.9	-112.9	-39.4	-184.6
France	-1950.8	-2888.6	-2582.3	-4516.7	-3218.2	-6452.0
Germany	-1252.2	-1453.0	-2302.4	-2548.0	-3304.9	-3602.5
Greece	-138.3	-266.0	-316.7	-512.5	-349.3	-651.2
Hungary	-3.4	-36.1	-54.5	-103.6	-125.9	-199.1
Ireland	-73.3	-136.8	-164.3	-265.0	-265.3	-425.8
Italy	-36.7	-476.6	-254.0	-837.8	-603.3	-1188.9

Latvia	-17.4	-20.0	-36.6	-49.6	-57.8	-79.7
Lithuania	-6.1	-18.1	-23.8	-45.1	-40.3	-71.7
Luxembourg	-0.8	-5.6	-5.5	-14.1	-7.7	-23.8
Malta	-0.2	-1.6	-1.0	-2.5	-1.4	-2.3
Netherlands	-48.1	-189.5	-123.0	-338.6	-266.4	-542.1
Poland	-1554.0	-1533.5	-3218.0	-2695.0	-4853.5	-4181.4
Portugal	-11.3	-23.9	-14.0	-37.8	-16.9	-48.5
Romania	16.6	-39.2	30.2	-67.9	55.3	-94.0
Slovakia	-7.9	-32.5	-22.4	-54.3	-46.3	-82.5
Slovenia	-40.8	-114.8	-175.2	-250.6	-173.3	-281.3
Spain	151.8	86.1	217.4	52.9	192.1	-37.4
Sweden	-204.8	-361.1	-341.9	-594.3	-493.7	-822.9
United Kingdom	-774.2	-1500.5	-1904.0	-2968.2	-2731.8	-4530.0

3.1.2.3 Detailed output for a sample country

The aggregated outputs from the energy demand models presented in the previous sections provide an overview of the input to the macroeconomic model ASTRA-EC. The inputs and data exchange between the models Invert/EE-Lab and to ASTRA-EC, however, are more detailed meso-level results, which are is illustrated for the country of France in this section. Similar results contributed to the inputs to the macroeconomic modelling of the other countries. For each EU 28 member state similar data exchange tables have been set up to transform the outputs of the energy demand model into inputs for macro-economic modelling.

Table 9: Overview of differences of investments by technology in Mio EUR for France, difference (D2) between increased-policies scenario and current-policy scenario, difference (D3) between new actor-related policies scenario and current-policy scenario

	2020		2025		2030	
Technology/scenario	**D2**	**D3**	**D2**	**D3**	**D2**	**D3**
Fossil Heating systems	-6.8	-212.6	-88.3	-233.4	15.5	-176.0
Biomass	333.6	337.4	4.3	62.0	111.8	78.4
Heat pumps	-8.0	343.1	-33.0	662.2	-148.2	828.0
District heating	-2.9	0.4	-11.9	-2.6	-9.2	-19.3
Electricity direct	-11.9	-46.5	7.2	19.5	77.3	15.6
Solar thermal	370.7	381.5	257.9	359.3	212.3	483.1
Building envelope related investments (refurbishments, maintenance, new constructions)	4522.2	6784.3	4143.0	6482.4	4881.1	8066.1

Table 10: Overview of differences of energy costs by technology in Mio EUR for France, difference (D2) between increased-policies scenario and current-policy scenario, difference (D3) between new actor-related policies scenario and current-policy scenario

	2020		2025		2030	
Technology/scenario	**D2**	**D3**	**D2**	**D3**	**D2**	**D3**
Electricity	-237.7	-385.6	-250.3	-439.8	-268.7	-490.1
District Heating	-51.0	103.0	-180.5	-12.1	-289.6	-193.1
Fuel Oil	-307.1	-508.1	-483.5	-843.2	-662.3	-1216.6
Natural Gas	-224.7	-1158.8	-508.3	-2274.8	-770.0	-3418.0
Coal	-11.7	-10.9	-4.6	-11.0	0.1	-6.3
Biomass	-1118.6	-928.2	-1155.1	-935.6	-1227.7	-1127.8

3.2 Input to macroeconomic model ASTRA-EC

This section presents the input for the ASTRA-EC model for the exemplary country France by economic sector. The investment impulse differentiates between appliances, subgroups of HVAC technologies (see section 2.2.2) and thermal retrofits. It is allocated to the investment vector and split up across sectors according to their contributions to the respective efficiency technologies. Changes in energy expenditures apply to the consumption vector and only accrue to the energy sector in ASTRA-EC. Subsidies are added to government consumption, which increases due to these subsidies.

3.2.1 Investments in appliances

Table 11: Overview of differences of investment expenditures for appliances by economic sector in Mio EUR for France, difference (D2) between increased-policies scenario and current-policy scenario, difference (D3) between new actor-related policies scenario and current-policy scenario

	2020		2025		2030	
Sector/scenario	**D2**	**D3**	**D2**	**D3**	**D2**	**D3**
Agriculture	0	0	0	0	0	0
Energy	0	0	0	0	0	0
Metals	0	0	0	0	0	0
Minerals	0	0	0	0	0	0
Chemicals	0	0	0	0	0	0
Metal Products	0	0	0	0	0	0
Industrial Machines	0	0	0	0	0	0
Computers	132.3	140.7	139.1	143.7	201.7	207.6
Electronics	328.6	974.2	3820.6	3942.6	3298.2	3415.7
Vehicles	0	0	0	0	0	0
Food	0	0	0	0	0	0

Textiles	0	0	0	0	0	0
Paper	0	0	0	0	0	0
Plastics	0	0	0	0	0	0
Other Manufacturing	0	0	0	0	0	0
Construction	0	0	0	0	0	0
Trade	0	0	0	0	0	0
Catering	0	0	0	0	0	0
Transport Inland	0	0	0	0	0	0
Transport Air Maritime	0	0	0	0	0	0
Transport Auxiliary	0	0	0	0	0	0
Communication	0	0	0	0	0	0
Banking	0	0	0	0	0	0
Other Market Services	0	0	0	0	0	0
Non Market Services	0	0	0	0	0	0

3.2.2 Investments in heating systems

Table 12: Overview of differences of investment expenditures for HVAC technologies by economic sector in Mio EUR for France, difference (D2) between increased-policies scenario and current-policy scenario, difference (D3) between new actor-related policies scenario and current-policy scenario

	2020		2025		2030	
Sector/scenario	**D2**	**D3**	**D2**	**D3**	**D2**	**D3**
Agriculture	0.0	0.0	0.0	0.0	0.0	0.0
Energy	0.0	0.0	0.0	0.0	0.0	0.0
Metals	0.0	0.0	0.0	0.0	0.0	0.0
Minerals	10.4	10.7	9.7	10.1	6.0	13.6
Chemicals	2.6	2.7	2.4	2.5	1.5	3.4
Metal Products	84.9	87.7	78.1	82.3	48.0	109.3
Industrial Machines	331.5	416.0	232.7	468.8	109.0	660.9
Computers	0.0	0.0	0.0	0.0	0.0	0.0
Electronics	26.5	27.5	24.2	25.7	14.8	33.7
Vehicles	0.0	0.0	0.0	0.0	0.0	0.0
Food	0.0	0.0	0.0	0.0	0.0	0.0
Textiles	0.0	0.0	0.0	0.0	0.0	0.0
Paper	0.0	0.0	0.0	0.0	0.0	0.0
Plastics	0.0	0.0	0.0	0.0	0.0	0.0
Other Manufacturing	0.0	0.0	0.0	0.0	0.0	0.0
Construction	162.5	170.0	111.7	163.7	68.2	235.6
Trade	57.2	63.0	41.9	64.4	24.2	93.0
Catering	0.0	0.0	0.0	0.0	0.0	0.0

Transport Inland	-0.7	25.7	2.7	49.6	-11.3	61.6
Transport Air Maritime	0.0	0.0	0.0	0.0	0.0	0.0
Transport Auxiliary	0.0	0.0	0.0	0.0	0.0	0.0
Communication	0.0	0.0	0.0	0.0	0.0	0.0
Banking	0.0	0.0	0.0	0.0	0.0	0.0
Other Market Services	-0.2	0.0	-0.6	-0.1	-0.5	-1.1
Non Market Services	0.0	0.0	-0.1	0.0	-0.1	-0.2

3.2.3 Investments in thermal retrofits

Table 13: Overview of differences of investment expenditures for thermal retrofits by economic sector in Mio EUR for France, difference (D2) between increased-policies scenario and current-policy scenario, difference (D3) between new actor-related policies scenario and current-policy scenario

	2020		2025		2030	
Sector/scenario	**D2**	**D3**	**D2**	**D3**	**D2**	**D3**
Agriculture	0.0	0.0	0.0	0.0	0.0	0.0
Energy	0.0	0.0	0.0	0.0	0.0	0.0
Metals	0.0	0.0	0.0	0.0	0.0	0.0
Minerals	452.2	678.4	428.9	648.2	488.1	806.6
Chemicals	0.0	0.0	0.0	0.0	0.0	0.0
Metal Products	90.4	135.7	85.8	129.6	97.6	161.3
Industrial Machines	45.2	67.8	42.9	64.8	48.8	80.7
Computers	0.0	0.0	0.0	0.0	0.0	0.0
Electronics	0.0	0.0	0.0	0.0	0.0	0.0
Vehicles	0.0	0.0	0.0	0.0	0.0	0.0
Food	0.0	0.0	0.0	0.0	0.0	0.0
Textiles	0.0	0.0	0.0	0.0	0.0	0.0
Paper	0.0	0.0	0.0	0.0	0.0	0.0
Plastics	452.2	678.4	428.9	648.2	488.1	806.6
Other Manufacturing	0.0	0.0	0.0	0.0	0.0	0.0
Construction	3391.6	5088.2	3216.9	4861.8	3660.8	6049.6
Trade	0.0	0.0	0.0	0.0	0.0	0.0
Catering	0.0	0.0	0.0	0.0	0.0	0.0
Transport Inland	0.0	0.0	0.0	0.0	0.0	0.0
Transport Air Maritime	0.0	0.0	0.0	0.0	0.0	0.0
Transport Auxiliary	0.0	0.0	0.0	0.0	0.0	0.0
Communication	0.0	0.0	0.0	0.0	0.0	0.0
Banking	90.4	135.7	85.8	129.6	97.6	161.3

Other Market Services	0.0	0.0	0.0	0.0	0.0	0.0
Non Market Services	0.0	0.0	0.0	0.0	0.0	0.0

3.2.4 Energy expenditures

Table 14: Overview of differences of energy expenditures by economic sector in Mio EUR for France, difference (D2) between increased-policies scenario and current-policy scenario, difference (D3) between new actor-related policies scenario and current-policy scenario

	2020		**2025**		**2030**	
Sector/scenario	**D2**	**D3**	**D2**	**D3**	**D2**	**D3**
...	0	0	0	0	0	0
Energy	-2224.1	-3231.8	-3486.3	-5654.0	-4449.7	-8025.3
...	0	0	0	0	0	0

3.2.5 Subsidies

Table 15: Overview of differences of government expenditures in Mio EUR for France, difference (D2) between increased-policies scenario and current-policy scenario, difference (D3) between new actor-related policies scenario and current-policy scenario

	2020		**2025**		**2030**	
Variable/scenario	**D2**	**D3**	**D2**	**D3**	**D2**	**D3**
Government expenditures	1253.6	1337.0	1709.1	1898.3	2001.0	2364.9

References

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List of abbreviations

GDP	Gross Domestic Product
HVAC	Heating, Ventilation and Air Conditioning
ICT	Information and Communication Technologies
IO	Input-Output
NUTS	Nomenclature of Territorial Units for Statistics
NACE	European sector classification: Nomenclature generale des Activites Economiques dans les Communautes Europeennes
NACE-CLIO	Is the branch of NACE 1970 used for the compilation of input-output tables

A. Appendix: Description of the ASTRA-EC model

A.1 The modelling approach

The ASTRA-EC-EC model is based on System Dynamics methodology. System Dynamics does not focus on the analysis of specific fields like economy or transport, but is a general methodology that can be applied to any kind of system meeting some basic conditions. In brief, a System Dynamics model consists of a set of hypotheses on the relationship between causes and resulting effects. Hypotheses may be based on theory or only informed by theory, but empirical inputs from statistics, surveys or other observations may also be used.

Relationships are represented by equations that are written and solved by mathematical simulation. In other words, a System Dynamic model does not have a specific set of unknown parameters or variables whose value is estimated as a solution of the model. Instead, most of the model variables change dynamically over time as an effect of the interaction of positive or negative feedback loops. This can be considered as the most important characteristics of any complex systems. System Dynamics models consist of three main types of variables: level, flow and auxiliary variables. The state of a variable is mainly calculated within level variables changed over time by inflows and outflows that are driven by auxiliary variables. Mathematically, level variables are solved with differential equations. Since, the solution of a system with a set of level variables is too complex, an approximation is applied by solving only the related difference equations. Nevertheless, the mathematical calculations in a large scale System Dynamics model like ASTRA-EC-EC are challenging and demanding on the computational equipment.

As opposed to computed general equilibrium models, reaching a steady state or equilibrium in each stage of the simulation is not foreseen in System Dynamics models. Dedicated software allows the development of System Dynamics models concentrating on the causal relationships by means of intuitive graphical interfaces.

The ASTRA-EC-EC model is therefore focused on the investigation of functional cause-and-effect relationships between the systems represented (transport, economy, environment) and connected through several feedback loops. The model is developed using Vensim® software.

A.2 Overview of the model structure

The model covers the time period from 1995 until 2050. Results in terms of main indicators are available on a yearly basis via a user interface. Geographically, ASTRA-EC-EC covers all EU28 member states plus Norway and Switzerland.

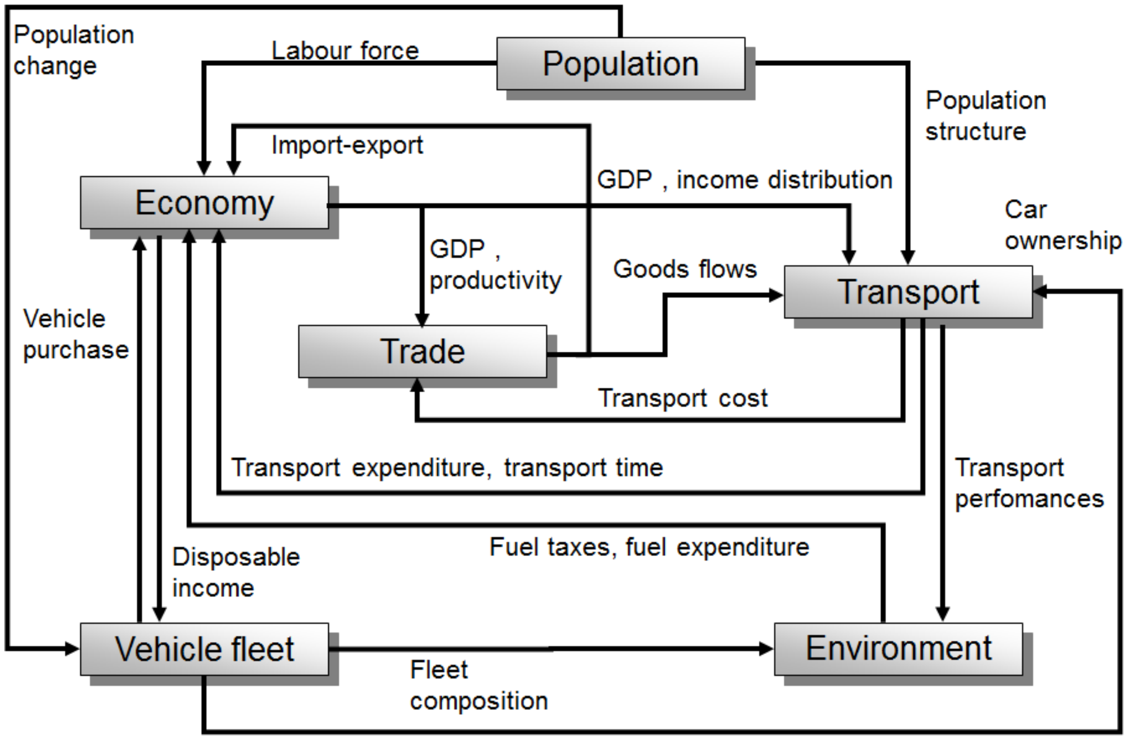
ASTRA-EC-EC consists of different modules, each related to one specific aspect, such as the economy, the transport demand, the vehicle fleet. The main modules cover the following aspects:

- Population and social structure (household types and income groups),
- Economy (including input-output tables, government, employment and investment),
- Foreign trade,
- Transport (including demand estimation, modal split, transport cost and infrastructure networks)
- Vehicle fleet (road),
- Environment (including pollutant emissions, CO_2 emissions, fuel consumption).

A key feature of ASTRA-EC-EC as an integrated assessment model is that the modules are linked together. Changes in one system are thus transmitted to other systems and can feed back to the original source of variation. For instance, changes in the economic system immediately feed into changes of the transport behaviour and alter origins, destinations and volumes of European transport flows. In turn, via some micro-macro bridges (see below), the changes in the transport system feed back into the economic system e.g. adapting the consumption behaviour of households or the sectoral interchange of intermediate goods and services.

Since all modules are part of the same dynamic structure, the whole model is simulated simultaneously. The most appealing consequence is that there is no need of iterations to align the results of the various modules. All parts of the model are always consistent to each other throughout the whole simulation.

An overview on the modules and their main linkages is presented in Figure 0-1.



Source: TRT - Fraunhofer-ISI

Figure 0-1: Overview of the linkages between the modules in ASTRA-EC-EC

A.3 Geographical scope and zoning system

Different levels of spatial categorizations are applied in parallel in ASTRA-EC-EC:

- The first categorization is based on the country level spatial differentiation, applied in all the modules of the model;

- The second categorization is founded on the NUTS I zones level, which is applied in the transport module to represent national trips;
- The third categorization is built on the NUTS II zones level, applied in the transport modules (for trips generation) as well as for population;

Further differentiation within NUTS II zones is provided in some modules like e.g. the transport module. Finally, for intercontinental trade and transport demand an aggregated zoning system is applied to non-European areas, including the following world regions: Arab-African Oil Exporters, Asian Oil Exporters, Brazil, China, East Asia, India, Japan, Latin America, North America, Oceania, Russia, South-Africa, South-Asia, Turkey, Rest-of-the-World.

At the European level, each country is treated separately in the model, resulting in a total of 30 states. The specific application of spatial categories in the modules of ASTRA-EC-EC is shown in the following table.

Table 0-1: Summary of spatial categorizations used in different modules of ASTRA-EC-EC

Spatial category	**Population**	**Macro-economic**	**Trade**	**Transport**	**Vehicle fleet**	**Environment**
Country	X	X	X	X	X	X
NUTS I	X			X		
NUTS II	X			X		
Urban context				X		
World regions			X	X		

Source: TRT / Fraunhofer-ISI

As highlighted in the table above, the transport module includes the most detailed level of spatial categorization, while in the other modules (except the population module) the variables are mainly defined at country level.

It would be desirable that the same level of spatial detail is available also for the other modules, but this is not feasible within a System Dynamics model calculating each variable for every time step from 1995 to 2050. When NUTS I and NUTS II level is used to describe transport demand, the size of the model becomes already quite big. Using the same detail throughout the model would lead to unsustainable computational problems due to the overall model size.

Therefore, the implementation of more detailed spatial categorizations only in the transport module results from a balanced judgment of factors: model requirements, soft- and hardware capabilities, data availability. Outside the transport module, the NUTS level is used only for selected socio-economic indicators.

A.4 Sectoral differentiation

Sectoral disaggregation in ASTRA-EC-EC is based on the concept of *NACE-CLIO* sectoral coding system where NACE stands for the general industrial classification of economic activities within the European communities and CLIO for Classification and nomenclature of input-output. Both are used Eurostat statistics, though the CLIO system is especially designed to generate harmonised input-output tables for the EU25 countries since each country used its own national system e.g. in Germany with 59 sectors or in the United Kingdom with 102 sectors.

Table 0-2: Differentiation into 25 economic sectors in ASTRA-EC-EC

Nr.	IOSector	TradeSector
1	Agriculture	T Agriculture
2	Energy	T Energy
3	Metals	T Metals
4	Minerals	T Minerals
5	Chemicals	T Chemicals
6	Metal Products	T Metal Products
7	Industrial Machines	T Industrial Machines
8	Computers	T Computers
9	Electronics	T Electronics
10	Vehicles	T Vehicles
11	Food	T Food
12	Textiles	T Textiles
13	Paper	T Paper
14	Plastics	T Plastics
15	Other Manufacturing	T Other Manufacturing
16	Construction	not included
17	Trade	T Other Services
18	Catering	T Other Services
19	Transport Inland	T Transport Services
20	Transport Air Maritime	T Transport Services
21	Transport Auxiliary	T Transport Services
22	Communication	T Other Services
23	Banking	T Other Services
24	Other Market Services	T Other Services
25	Non Market Services	T Other Services

Source: Fraunhofer-ISI

The NACE system corresponds to international classifications like *ISIC* (International Standard Industrial Classification), such that also data following these categorisations could be used, and is available as NACE with 17, 25 or 44 sectors. Three main reasons suggest using the NACE-CLIO version with 25 sectors (see following table): firstly, in ASTRA-EC-EC the use of harmonised input-output tables for the EU27+2 countries is of significant importance to reflect the economic interactions that are induced in all sectors of the national economies by influences of policies in those sectors that are directly related to transport demand. Eurostat provides such tables for most of the EU27 countries plus Norway and Switzerland for 1995. Values for 1995 are required as the sectoral interweavement is initiated by data. Input output tables of upcoming years are endogenously calculated based on changing final use. They are not calibrated against input output tables of following years. Secondly, the split into 25 sectors offers five sectors that are directly related to transport demand changes and that would be affected by transport policies. These sectors are sector 2 Refined petroleum products and Electric power, gas, etc. influenced by private expenditures for fuel; sector 10 Transport Equipment affected by private car purchase and investments in any other kind of vehicles; sector 16 Building and Construction driven among others by investments in transport facilities (e.g. container terminals or stations) and transport networks; sector 19 Inland Transport Services influenced by expenditures for bus, rail, road freight transport and inland waterway transport; sector 20 Maritime and Air Transport Services affected by ocean ship transport and air transport. Thirdly, among the 25 sectors are already 9 service sectors which enable the model to take account of the ever increasing importance of services for the European economies. A conversion table from the NACE Revision 2 classification of economic sectors (65 sectors) to the NACE-CLIO version called IOSector (25 sectors) is provided below.

Table 0-3: Conversion factors from NACE Rev. 2 CPA 65 classification to ASTRA-EC-EC NACE-CLIO 25 classification

NACE Rev.2	**Sector Name**	**IOSector**	**Conversion**
A_01	Products of agriculture, hunting and related services	Agriculture	1
A_02	Products of forestry, logging and related services	Agriculture	1
A_03	Fish and other fishing products; aquaculture products; support services to fishing	Agriculture	1
B	Mining and quarrying	Metals	0.43
B	Mining and quarrying	Minerals	0.21
B	Mining and quarrying	Energy	0.36
C_10-12	Food products, beverages and tobacco products	Food	0.9
C_10-12	Food products, beverages and tobacco products	Other Manufacturing	0.1
C_13-15	Textiles, wearing apparel and leather products	Textiles	1
C_16	Wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	Other Manufacturing	1
C_17	Paper and paper products	Paper	1
C_18	Printing and recording services	Paper	0.5
C_18	Printing and recording services	Other Manufacturing	0.5
C_19	Coke and refined petroleum products	Energy	1
C_20	Chemicals and chemical products	Chemicals	1
C_21	Basic pharmaceutical products and pharmaceutical preparations	Chemicals	1

C_22	Rubber and plastics products	Plastics	1
C_23	Other non-metallic mineral products	Minerals	1
C_24	Basic metals	Metals	1
C_25	Fabricated metal products, except machinery and equipment	Metal_ Products	1
C_26	Computer, electronic and optical products	Computers	1
C_27	Electrical equipment	Electronics	1
C_28	Machinery and equipment n.e.c.	Industrial Machines	1
C_29	Motor vehicles, trailers and semi-trailers	Vehicles	1
C_30	Other transport equipment	Vehicles	1
C_31-32	Furniture; other manufactured goods	Other_ Manufacturing	1
C_33	Repair and installation services of machinery and equipment	Trade	1
D	Electricity, gas, steam and air-conditioning	Energy	1
E_36-37	Natural water; water treatment and supply services	Energy	1
E_38-39	Sewerage; waste collection, treatment and disposal activities; materials recovery; remediation activities and other waste management services	Non Market Services	1
F	Constructions and construction works	Construction	1
G_45	Wholesale and retail trade and repair services of motor vehicles and motorcycles	Trade	1
G_46	Wholesale trade services, except of motor vehicles and motorcycles	Trade	1
G_47	Retail trade services, except of motor vehicles and motorcycles	Trade	1
H_49	Land transport services and transport services via pipelines	Transport Inland	1
H_50	Water transport services	Transport Air Maritime	1
H_51	Air transport services	Transport Air Maritime	1
H_52	Warehousing and support services for transportation	Transport Auxiliary	1
H_53	Postal and courier services	Communication	1
I	Accommodation and food services	Catering	1
J_58	Publishing services	Other Market Services	1
J_59	Motion picture, video and television programme production services, sound recording and music publishing; programming and broadcasting services	Other Market Services	1
J_60	Telecommunications services	Other Market Services	1
J_62-63	Computer programming, consultancy and related services; information services	Other Market Services	1
K_64	Financial services, except insurance and pension funding	Banking	1

K_65	Insurance, reinsurance and pension funding services, except compulsory social security	Banking	1
K_66	Services auxiliary to financial services and insurance services	Banking	1
L	Real estate services	Other Market Services	1
L_68	Of which: imputed rents of owner-occupied dwellings	Other Market Services	1
M_69-70	Legal and accounting services; services of head offices; management consulting services	Other Market Services	1
M_71	Architectural and engineering services; technical testing and analysis services	Other Market Services	1
M_72	Scientific research and development services	Other Market Services	1
M_73	Advertising and market research services	Other Market Services	1
M_74-75	Other professional, scientific and technical services; veterinary services	Other Market Services	1
N_77	Rental and leasing services	Other Market Services	1
N_78	Employment services	Other Market Services	1
N_79	Travel agency, tour operator and other reservation services and related services	Catering	1
N_80-82	Security and investigation services; services to buildings and landscape; office administrative, office support and other business support services	Other Market Services	1
O	Public administration and defence services; compulsory social security services	Non Market Services	1
P	Education services	Non Market Services	0.8
P	Education services	Other Market Services	0.2
Q_86-87	Human health services	Non Market Services	0.8
Q_86-87	Human health services	Other Market Services	0.2
Q_88	Social work services	Non Market Services	1
R_90-91	Creative, arts and entertainment services; library, archive, museum and other cultural services; gambling and betting services	Non Market Services	0.1
R_90-91	Creative, arts and entertainment services; library, archive, museum and other cultural services; gambling and betting services	Other Market Services	0.9
R_92-93	Sporting services and amusement and recreation services	Other Market Services	1
S_94	Services furnished by membership organisations	Non Market Services	1
S_95	Repair services of computers and personal and household goods	Other Market Services	1
S_96	Other personal services	Other Market Services	1
T	Services of households as employers; undifferentiated goods and services produced by households for own use	Other Market Services	1

U	Services provided by extraterritorial organisations and bodies	Other Market Services	1

Source: Fraunhofer-ISI