Technical report on macroeconomic Member State results of the EUCO policy scenarios

By E3MLab, December 2016

Contents

Introduction

In the context of the 2016 Impact Assessment work of the European Commission, a number of policy scenarios were prepared by a consortium led by E3Mlab[1], hosted at the National Technical University of Athens (NTUA), and including the International Institute for Applied System Analysis (IIASA). This technical note briefly introduces these scenarios and presents the macroeconomic results of those.

Two core scenarios, EUCO27 and EUCO30 were built based on the EU Reference Scenario 2016[2] and designed to achieve the 2030 targets as agreed by the European Council[3]. The analysis of impacts of the two policy scenarios was the input[4] to the Effort Sharing Regulation Impact Assessment[5] and the Staff Working Document[6] accompanying the Communication on low-emission mobility strategy

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[1] http://www.e3mlab.eu

[2] https://ec.europa.eu/energy/sites/ener/files/documents/ref2016_report_final-web.pdf

[3] http://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/ec/145397.pdf

[4] The scenario runs in this document are those used for the Effort Sharing Regulation Impact Assessment and the Impact Assessment accompanying the proposal for a revised Energy Efficiency Directive. Some minor technical changes were performed for sector-specific modelling in other analytical documents.

[5] http://ec.europa.eu/clima/policies/effort/proposal/index_en.htm

[6] http://ec.europa.eu/transport/themes/strategies/news/2016-07-20-decarbonisation_en

published in July 2016, as well as the Impact Assessment accompanying the proposal for recast of the Directive on the promotion of energy from renewable sources[7] and the Impact Assessment accompanying the proposal for revised Energy Efficiency Directive[8] published in November 2016[9]. Using two core scenarios ensures consistency of the proposals and increases the robustness of policy conclusions.

In addition, the EUCO+ scenarios and the EUCO3030 sensitivity were also prepared. The EUCO+ scenarios were presented only in the Impact Assessment accompanying the proposal for revised Energy Efficiency Directive. The EUCO3030 sensitivity[10] was presented both in the Impact Assessment accompanying the proposal for revised Energy Efficiency Directive and the Impact Assessment accompanying the proposal for recast of the Directive on the promotion of energy from renewable sources.

All scenarios reflect the current EU policy design when modelling the cost-effective achievement of 2030 targets.

For the two Impact Assessments mentioned in the above paragraph, macro-economic modelling was also undertaken in order to estimate the impacts of the scenarios on macro-economic level (e.g. GDP growth and jobs). It is worth noting that distributional elements of proposals on the Effort Sharing Regulation or the EU ETS Revision are not taken into account in the scenarios.

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[7] https://ec.europa.eu/energy/en/news/eu-leading-renewable-energy

[8] https://ec.europa.eu/energy/en/news/commission-proposes-30-energy-efficiency-target

[9] The EUCO27 was also the starting point for the Impact Assessment accompanying the proposal for revised rules for the electricity market, risk preparedness and ACER.

[10] It is reminded that this sensitivity used the same ETS carbon prices as the EUCO30 scenario.

Modelling the macro-economic impacts of the policy scenarios with the GEM-E3 model

For the modelling of the macro-economic impacts of all the policy scenarios, the GEM-E3 model was used by E3Mlab, which took as input the key elements of the scenarios in terms of energy, GHG emissions and transport projections.

The GEM-E3 model is a multi-regional, multi-sectoral, dynamic computable general equilibrium (CGE) model which represents all kinds of interactions of the economy with the environment and the energy system. It has been frequently used for macroeconomic assessment of energy and climate policies.

The model allows for a consistent comparative analysis of policy scenarios since it ensures that in all scenarios, the economic system remains in general equilibrium. In addition, it incorporates micro-economic mechanisms and institutional features and is able to provide insights of the distributional aspects of long-term structural adjustments. The version of the GEM-E3 model used in this study is the latest one developed and maintained by E3MLab. This version includes a fully-fledged representation of the financial system, which is important for the macroeconomic impact assessment, as the reduction of GHG emissions implies increases in capital intensiveness in many energy-related sectors. The new power technologies, the vehicles with lower fuel consumption and the energy efficiency investments require higher upfront expenditures in exchange for lower operating costs. The increased capital requirements exert pressures on capital markets and lead to crowding out effects for households and firms.

Compared to previous impact assessment studies, the modelling has been further developed in order to assess different financing mechanisms for energy efficiency investments. Using the newly

developed financial mechanisms in GEM-E3, the macroeconomic study quantified several variants of model runs to evaluate the role of financing. Among those variants, two contrasted cases were presented in the Impact Assessment accompanying the proposal for revised Energy Efficiency Directive and are included in this note, namely those referred to as *"self-financing"* and *"loan-based financing"*:

- In the *"self-financing"* case, no additional borrowing is possible, relative to baseline, and thus economic agents bear income limitations when funding investments in energy efficiency and renewables;

In the *"loan-based financing"* case, firms and households can borrow in capital markets without facing increasing unit costs of funding.

None of these contrasted cases are expected to be fully true in reality. Therefore, the analysis estimates a range of possibilities[11].

In both cases, the firms and households finance their investments in energy efficiency by spending less on other commodities and investment purposes ("crowding-out" effect). The crowding-out effect is higher in the former case than in the latter.

In modelling terms, the self-financing variant corresponds to the savings-investment closure used in standard computable general equilibrium models. In the loan-based variant, the agents can distribute capital costs over several years to alleviate crowding out effects. However, the agents are modelled to annually pay back interests and principal of the loans, at a level as required to meet a financial sustainability rule, based on a reasonable debt to income ratio.

The general equilibrium perspective implies that the policy scenarios introduce additional goals or constraints (such as for GHG emissions reduction, RES shares and energy efficiency targets) compared to the reference projection[12] and thus the scenarios entail higher investment costs, which in some cases may lead to higher levelized unit costs of useful energy services[13] during the transition period [14]. Technology progress, induced by the growing demand and hence mass production of new energy technologies, equipment, vehicles, appliances etc. in all sectors, is the main source of cost reduction. Also learning-by-doing[15] effects can be observed. In addition, the policies included in the EUCO scenarios may remove non market barriers that were obstructing full uptake of the most efficiency technologies in the reference projection, while technology standards such as in the eco-design push new cost-efficient products closer to market acceptance. Thus, the EUCO scenario includes conditions enabling cost reductions relative to the Reference scenario 2016.

Consequently, in the long term, cost savings due to energy efficiency can, in some cases, over-

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[11] Please see more discussion on this topic in the Impact Assessment (SWD(2016) 405 final), where the Commission services express the view that "loan-based financing" variant is more realistic.

[12] The macroeconomic analysis draws on comparisons of model-based projections for two scenarios, usually a policy scenario, such as a EUCO/EUCO+ and a reference scenario (in this case, the EU Reference scenario 2016, see footnote 2).

[13] Useful energy services are for example mobility, heating, steam uses in industry, etc.

[14] The levelized unit cost of energy services includes fuel purchasing costs, maintenance and other operating costs, as well as annualized cost of purchasing energy equipment, appliances, vehicles, etc. and investment in energy efficiency (e.g. insulation of houses, control systems in industry, etc.).

[15] The learning by doing mechanism is semi-endogenous in the model version used in this study. In general, the EUCO/EUCO+ scenarios assume that the new technologies, mainly those that are not yet fully mature today, reach high technology readiness levels in the long run and get close to floor costs, thanks to massive production.

compensate the increased equipment costs. However, the cost-reduction mechanisms, as described above, cannot always fully offset the cost effects in the policy scenarios and thus the economic agents may still bear cost increases, to some extent, relative to the reference case, at least during a transition period. These may, in turn, lead to slight reduction of private consumption in the policy scenarios compared to the reference scenario, and thus consumption of other commodities, not involved in the energy-related investment, may decrease relative to the reference case. This induces negative, albeit small in magnitude, effects on Gross Domestic Product (GDP), despite the significant increase of demand for energy efficiency related goods and services (equipment, materials, appliances, vehicles) supporting investment in the entire economy. The increase in demand for energy efficiency related goods and services exerts positive impacts on the economy, as it stimulates domestic production in several sectors and tends to increase employment.

Tightness in the capital market, hence increased cost of financing in the policy scenarios, implies higher costs of the energy services and thus aggravate the crowding out effects, which in turn reduce GDP compared to the reference case.

In contrast, easiness of financing diminishes the crowding out effects, eventually allowing activity benefits induced by energy-related investment to over-compensate the effects of increased energy service costs on GDP. In this case, positive effects on GDP and employment can be seen in some EUCO scenarios, relative to the Reference scenario 2016. These positive effects diminish with stringency of the energy efficiency policies for the following reasons: firstly, increasing financing requirements implied by the EUCO+ scenarios increase the demand for funding and hence increase lending interest rates, which in turn adversely impact other sectors of the economy. Secondly, very high ambition in energy efficiency implies high marginal investment costs for

incremental savings, hence diminishing expected returns on this investment.

Further information on modelling of macro-economic impacts is provided in the Impact Assessment accompanying the legislative proposal on the Energy Efficiency Directive[16].

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[16] SWD(2016)405 final.

Appendix I.a: Macro-economic results of EUCO27 scenario in 2030

	GDP (€'13 billion)		Employment (million persons)	
	Self-financing	Loan-based financing	Self-financing	Loan-based financing
Austria	409.23	409.87	4.27	4.28
Belgium	489.69	492.09	5.09	5.11
Bulgaria	55.09	55.41	2.53	2.55
Croatia	55.26	55.60	1.45	1.46
Cyprus	23.02	23.14	0.41	0.41
Czech Republic	222.12	223.13	4.67	4.68
Denmark	351.75	352.55	2.81	2.82
Estonia	24.67	24.83	0.51	0.52
Finland	230.39	231.29	2.45	2.45
France	2 646.62	2 654.57	27.85	27.90
Germany	3 291.02	3 301.41	35.16	35.22
Greece	226.64	227.15	3.95	3.96
Hungary	145.00	146.16	4.20	4.22
Ireland	251.39	251.66	1.79	1.79
Italy	1 900.94	1 906.79	23.57	23.64
Latvia	34.00	34.24	0.66	0.66
Lithuania	44.47	44.64	0.81	0.81
Luxembourg	71.80	71.89	0.35	0.35
Malta	10.29	10.30	0.19	0.19
Netherlands	752.57	755.39	8.24	8.25
Poland	616.86	621.15	15.13	15.24
Portugal	218.68	218.93	4.15	4.15
Romania	195.69	196.51	7.09	7.12
Slovakia	118.15	118.56	2.17	2.18
Slovenia	49.45	49.72	0.87	0.88
Spain	1 442.12	1 445.81	19.20	19.24
Sweden	587.43	589.07	5.14	5.15
United Kingdom	2 443.07	2 449.83	31.30	31.36
EU28	16 907.39	16 961.70	216.02	216.59

Appendix I.b: Macro-economic results of EUCO30 scenario in 2030

All figures show percentage changes of projections for the year 2030, relative to the EUCO27 scenario.

	GDP (% change from EUCO27)		Employment (% change from EUCO27)	
	Self-financing	Loan-based financing	Self-financing	Loan-based financing
Austria	-0.13	0.20	0.00	0.20
Belgium	-0.33	0.23	-0.14	0.18
Bulgaria	-0.31	0.54	-0.61	0.13
Croatia	-0.64	0.28	-0.90	0.08
Cyprus	-0.16	0.10	-0.19	0.10
Czech Republic	-0.24	0.39	-0.45	0.05
Denmark	-0.24	0.12	-0.12	0.14
Estonia	-0.48	0.42	-0.24	0.31
Finland	-0.13	0.38	-0.06	0.25
France	-0.19	0.31	-0.05	0.23
Germany	-0.28	0.21	-0.05	0.21
Greece	-0.05	0.25	-0.04	0.24
Hungary	-0.30	0.80	-0.44	0.26
Ireland	0.06	0.25	0.09	0.26
Italy	-0.04	0.45	-0.10	0.30
Latvia	-0.80	0.19	-0.68	0.39
Lithuania	-0.57	0.05	-0.21	0.31
Luxembourg	-0.08	0.19	0.02	0.21
Malta	-0.58	-0.25	-0.35	-0.05
Netherlands	-0.16	0.34	0.01	0.17
Poland	-1.00	0.10	-1.01	0.10
Portugal	-0.09	0.38	-0.10	0.29
Romania	-0.41	0.22	-0.80	-0.08
Slovakia	-0.16	0.46	-0.38	0.14
Slovenia	-0.38	0.21	-0.23	0.16
Spain	-0.03	0.29	-0.03	0.25
Sweden	-0.22	0.17	-0.03	0.19
United Kingdom	-0.24	0.14	-0.04	0.19
EU28	-0.22	0.26	-0.18	0.20

Appendix I.c: Macroeconomic results of EUCO+33 scenario in 2030

All figures show percentage changes of projections for the year 2030, relative to the EUCO27 scenario.

	GDP (% change from EUCO27)		Employment (% change from EUCO27)	
	Self-financing	**Loan-based financing**	**Self-financing**	**Loan-based financing**
Austria	-0.46	0.21	-0.02	0.39
Belgium	-1.06	0.13	-0.40	0.29
Bulgaria	-0.96	0.66	-1.40	-0.10
Croatia	-1.24	0.60	-1.86	0.10
Cyprus	-0.56	-0.09	-0.44	0.09
Czech Republic	-1.02	0.38	-1.31	-0.13
Denmark	-0.52	0.14	-0.25	0.24
Estonia	-1.79	0.36	-0.82	0.47
Finland	-0.93	0.60	-0.45	0.45
France	-0.86	0.19	-0.21	0.37
Germany	-0.73	0.29	-0.11	0.43
Greece	-0.49	-0.01	-0.18	0.30
Hungary	-1.33	0.99	-1.24	0.28
Ireland	-0.12	0.21	0.15	0.42
Italy	-0.38	0.52	-0.40	0.29
Latvia	-2.40	-0.12	-1.84	0.58
Lithuania	-1.84	-0.28	-0.64	0.53
Luxembourg	-0.29	0.19	0.02	0.34
Malta	-0.80	-0.37	-0.69	-0.23
Netherlands	-0.80	0.40	-0.11	0.32
Poland	-2.67	-0.25	-2.80	-0.30
Portugal	-0.74	0.04	-0.31	0.38
Romania	-1.22	0.11	-1.80	-0.32
Slovakia	-1.08	0.28	-1.27	-0.18
Slovenia	-1.43	0.10	-0.79	0.19
Spain	-0.41	0.19	-0.14	0.39
Sweden	-0.71	0.15	-0.12	0.36
United Kingdom	-0.85	-0.05	-0.14	0.31
EU28	-0.79	0.21	-0.51	0.28

Appendix I.d: Macro-economic results of EUCO+35 scenario in 2030

All figures show percentage changes of projections for the year 2030, relative to the EUCO27 scenario.

	GDP (% change from EUCO27)		Employment (% change from EUCO27)	
	Self-financing	Loan-based financing	Self-financing	Loan-based financing
Austria	-0.71	0.29	-0.04	0.57
Belgium	-1.74	0.05	-0.68	0.38
Bulgaria	-1.71	0.89	-2.31	-0.24
Croatia	-1.61	1.00	-2.61	0.16
Cyprus	-1.01	-0.28	-0.75	0.09
Czech Republic	-1.82	0.37	-2.18	-0.26
Denmark	-0.81	0.10	-0.32	0.37
Estonia	-3.14	0.17	-1.42	0.61
Finland	-1.69	0.68	-0.83	0.59
France	-1.48	0.15	-0.36	0.52
Germany	-1.12	0.29	-0.15	0.62
Greece	-0.65	0.07	-0.23	0.47
Hungary	-2.29	1.14	-2.00	0.33
Ireland	-0.29	0.21	0.18	0.57
Italy	-0.75	0.58	-0.68	0.38
Latvia	-3.93	-0.47	-3.02	0.68
Lithuania	-3.07	-0.72	-1.10	0.62
Luxembourg	-0.43	0.25	0.06	0.51
Malta	-1.02	-0.43	-0.95	-0.29
Netherlands	-1.53	0.42	-0.33	0.47
Poland	-4.33	-0.68	-4.49	-0.66
Portugal	-1.30	-0.14	-0.55	0.46
Romania	-2.07	-0.04	-2.81	-0.58
Slovakia	-2.07	0.06	-2.06	-0.33
Slovenia	-1.93	0.29	-1.03	0.38
Spain	-0.87	0.08	-0.25	0.52
Sweden	-1.20	0.15	-0.24	0.51
United Kingdom	-1.49	-0.22	-0.32	0.42
EU28	-1.35	0.16	-0.84	0.36

Appendix I.e: Macro-economic results of EUCO+40 scenario in 2030

All figures show percentage changes of projections for the year 2030, relative to the EUCO27 scenario.

	GDP (% change from EUCO27)		Employment (% change from EUCO27)	
	Self-financing	**Loan-based financing**	**Self-financing**	**Loan-based financing**
Austria	-1.47	0.33	-0.35	1.02
Belgium	-2.75	-0.16	-1.16	0.61
Bulgaria	-3.29	0.47	-3.86	-0.89
Croatia	-1.99	1.63	-3.61	0.13
Cyprus	-1.52	-0.73	-1.04	0.15
Czech Republic	-2.90	0.44	-3.63	-0.61
Denmark	-1.01	0.17	-0.36	0.75
Estonia	-5.56	-0.50	-2.72	0.86
Finland	-2.80	0.94	-1.51	0.93
France	-2.63	-0.15	-0.79	0.82
Germany	-1.60	0.58	-0.29	1.15
Greece	-0.89	-0.06	-0.34	0.74
Hungary	-3.50	1.67	-3.14	0.50
Ireland	-0.24	0.40	0.31	1.00
Italy	-1.05	0.74	-1.16	0.61
Latvia	-6.24	-1.24	-5.01	0.97
Lithuania	-4.53	-1.75	-1.71	0.88
Luxembourg	-0.63	0.32	0.14	0.88
Malta	-1.46	-0.71	-1.44	-0.48
Netherlands	-2.65	0.51	-0.80	0.87
Poland	-6.50	-1.58	-6.91	-1.55
Portugal	-1.89	-0.50	-0.83	0.75
Romania	-3.04	-0.52	-4.22	-1.35
Slovakia	-3.34	-0.52	-3.26	-0.76
Slovenia	-2.90	0.49	-1.69	0.66
Spain	-1.44	-0.19	-0.41	0.88
Sweden	-2.23	0.09	-0.67	0.85
United Kingdom	-2.23	-0.65	-0.52	0.69
EU28	-2.12	0.06	-1.36	0.56

Appendix I.f: Macro-economic results of EUCO3030 sensitivity in 2030

All figures show percentage changes of projections for the year 2030, relative to the EUCO27 scenario.

	GDP (% change from EUCO27)		Employment (% change from EUCO27)	
	Self-financing	Loan-based financing	Self-financing	Loan-based financing
Austria	-0.54	-0.04	-0.12	0.15
Belgium	-0.61	0.05	-0.24	0.11
Bulgaria	-0.99	0.24	-1.24	-0.23
Croatia	-0.73	0.25	-0.94	0.06
Cyprus	-0.30	0.01	-0.31	0.00
Czech Republic	-0.66	0.17	-0.71	-0.08
Denmark	-0.28	0.06	-0.07	0.16
Estonia	-1.47	0.28	-0.68	0.20
Finland	-0.98	0.23	-0.53	0.18
France	-0.45	0.16	-0.12	0.19
Germany	-0.56	0.09	-0.12	0.18
Greece	-0.26	0.18	-0.20	0.17
Hungary	-0.73	0.59	-0.65	0.18
Ireland	-0.14	0.31	-0.09	0.21
Italy	-0.18	0.40	-0.24	0.11
Latvia	-0.95	0.10	-0.71	0.35
Lithuania	-0.68	-0.04	-0.20	0.29
Luxembourg	-0.30	0.04	-0.08	0.15
Malta	-0.88	-0.45	-0.61	-0.24
Netherlands	-0.48	0.25	-0.06	0.16
Poland	-1.59	-0.25	-1.42	-0.16
Portugal	-0.25	0.27	-0.15	0.25
Romania	-0.56	0.08	-0.84	-0.15
Slovakia	-0.87	0.01	-0.77	-0.11
Slovenia	-0.61	0.03	-0.32	0.09
Spain	-0.21	0.17	-0.08	0.21
Sweden	-0.53	0.01	-0.11	0.17
United Kingdom	-0.47	0.00	-0.11	0.14
EU28	-0.49	0.13	-0.29	0.14