European Commission

JRC TECHNICAL REPORTS

Analysis of the use of models by the European Commission in its Impact Assessments for the period 2009 - 2014

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2017

Joint Research Centre

EUR 28628 EN

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JRC Science Hub
https://ec.europa.eu/jrc

JRC105329

EUR 28628 EN

PDF	ISBN 978-92-79-69283-3	ISSN 1831-9424	doi:10.2760/096340
Print	ISBN 978-92-79-69284-0	ISSN 1018-5593	doi:10.2760/656266

Luxembourg: Publications Office of the European Union, 2017

How to cite this report: Petrov L.O., Annoni P., Acs S., Schade B., Gisolo E., Kulvinskaite G., Gancheva M., Christou M., Otto J., *Analysis of the use of models by the European Commission in its Impact Assessments for the period 2009 – 2014*, EUR 28628 EN, Publications Office of the European Union, Luxembourg, ISBN 978-92-79-69283-3, doi:10.2760/096340, JRC105329.

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Acknowledgements

We wish to express our appreciation to Professor Emeritus Leen Hordijk for having initiated this work and for his continued guidance and support.

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Executive summary

Impact Assessments (IA)are a key element in the development of policy proposals by the European Commission (EC). They provide evidence for political decision makers on the advantages and disadvantages of possible policy options by assessing their potential impacts. This evidence should be quantified whenever possible, and hence it is of interest to examine to what extent models have been used in IAs. The purpose of this report is to understand how the EC is positioned with respect to external providers as regards modelling contributions to IAs, as well to provide an input into potential future development of the Commission's model portfolio. The results of a statistical analysis for the period 2009-2014 shows that 16 % of the published 512 IAs used models or were predominantly model-based. In terms of absolute numbers, Directorate Generals (DGs)[1] CLIMA, ENER, ENV and MOVE account for more than half (51) of the 91 model-based IAs[2]. Within the model-based IAs, 52% used results exclusively or partially provided by external contractors, while 48% used models run in-house by DG JRC. The Commission uses a wide range of models (91 for the IAs during 2009-2014), roughly 60% of which were used only once. The 24 most frequently-used models represent 70% of all cases in which modelling were used for an IA. Notably 11 of them account for roughly 48%, almost all being run by contractors, mostly in tandem for energy-transport-climate policy scenarios.

The most frequently-used model is PRIMES, used in 28 out of 263 cases (11% of the cases), followed by 10 other models which are used exclusively or predominantly with PRIMES in the context of the energy-climate scenarios (GEM-E3, TREMOVE, CAPRI, POLES, G4M, GAINS, GLOBIOM, LUISA, PROMETHEUS and TRANSTOOLS).

Frequently-used models for the economic and monetary union are the in-house models QUEST and SYMBOL.

The most frequently-used models of DG JRC number about 10 which have been used in 46 cases; these are energy models (GEM-E3 and POLES), followed by environmental models (the LUISA modelling platform and LISFLOOD), the micro-economic model for financial markets SYMBOL, the transport model TRANSTOOLS and the agricultural models belonging to the iMAP platform - CAPRI and AGLINK-COSIMO.

[1] Please note that throughout the paper, the DGs are identified by the acronyms in the period examined (for their names please see List of abbreviations and definitions).

[2] Please note that the total number of IAs by DG do not coincide with the total number of IAs of Table 1 as in some cases more DGs have been involved in the same IA. In these cases the IA is assigned to every involved DG.

1 Introduction

Impact Assessments (IA) provide evidence for political decision makers on the advantages and disadvantages of possible policy options areas and are key element in the development of Commission policy proposals. They are required by the Better regulation Guidelines[3] for those proposals which are likely to have a significant economic, social or environmental impact. Indeed, IAs are the basis for the political negotiations on policy proposals in the EU institutions. The Guidelines further stipulate that evidence should be quantified as far as possible, while being transparent about assumptions, uncertainties and methods.

It is therefore of interest to examine to which extent models have been used in EC's IAs and what is the reliance on in-house models and those provided by external contractors, with a view to identifying major gaps in the Commission's model portfolio. This is of particular relevance since the Commission has an in-house science service, the DG JRC, whose mission it is to provide independent scientific-technical evidence for policy making. In recent years, DG JRC has been aiming to further improve its relevance to policy making through a more systematic involvement in the IAs.

[3] SWD(2015) 111 final; these guidelines update and extend those published in 2005 (SEC(2005)790) and revised in 2009 SEC(2009) 92.

2 Scope and Methodology

The present statistical analysis is restricted to the years 2009-2014. It focuses on quantitative results, with limited qualitative interpretation as to the use of external versus EC-run models. It examines modelling[4] contributions only, excluding information systems and data. The analysis also excludes accounting-type models such as the Standard Cost Model of the EC, widely used to assess implementation (administrative, regulatory) costs.

In order to identify the in-house and third-party modelling contributions to the EC's IAs, a step-wise approach was adopted. The analysis consists of the following steps:

1. Identification of the information sources;
2. Document search by relevant keywords;
3. Brief description of each identified model-based IA;
4. Extraction of summary information by using basic descriptive statistics;
5. Cross-checking with internal JRC inventories (MIDAS – JRC Modelling Inventory Database & Access Services and PAR - Periodic Action Review, which is an internal evaluation and databases).

The source of information for the analysis is the EC's rolling list of published IAs[5].

The IA documents have been searched with a list of keywords and acronyms of about 80 models. Those IAs with sections on methodology and external expertise were scrutinized in depth.

For the statistical analysis, we counted all instances of models quoted in a given IA as having contributed to its evidence base. That is, we counted references to models used in previously executed studies (carried out for the EC). This means, in particular, that more fundamental modelling exercises, such as for the Energy Reference Scenario, were counted both in the IA for which they were carried out and in all instances in which they were quoted in subsequent IAs (typically, a Communication followed by various Directives and/or Regulations). We counted an IA only once if it is the same one that was used for several pieces of legislation. Different basic descriptive statistics have been computed starting from the different IAs by year, by DG and by model.

It is important to underline that this analysis is based on a limited number of years, from 2009 to 2014. The reason for this choice of years is because it corresponds essentially to the duration of the Commission (2010-2014) with only changes to the numbers and responsibilities of the policy DGs. Also, it is based solely on the set of official documents published by the Commission. The analysis thus depends on a clear identification of the methodology, models and their authors/contributors in the IA reports - which it turned out to not be always available.

[4] A model is a set of mathematical concepts and language to simulate and describe the behaviour of a (economic, environmental, biological, physical, etc.) system composed by entities and their mutual interactions. In general all models have an information input, and an output of estimated results.

[5] http://ec.europa.eu/smart-regulation/impact/ia_carried_out/cia_2014_en.htm

3 Results and Discussions

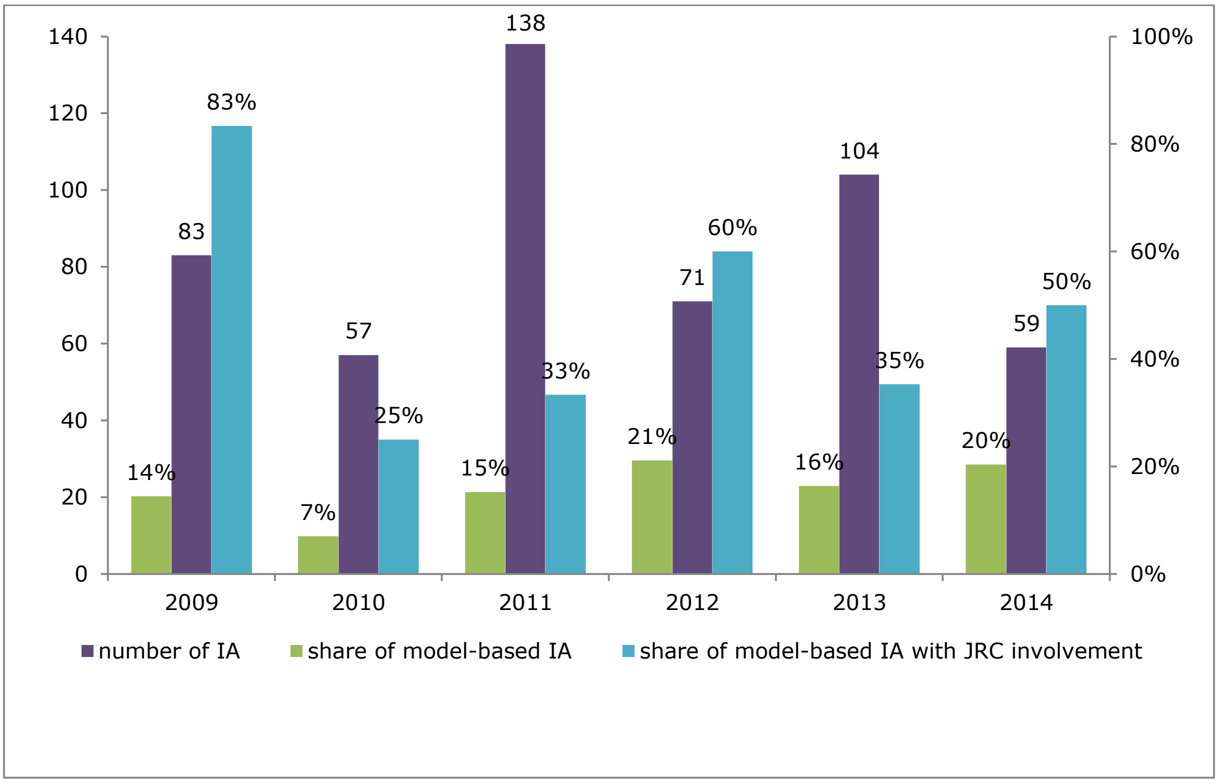
3.1 Model use in IAs per DG

The EC published 512 IAs in the period 2009-2014, 16% of which used models or were predominantly model-based (Table 1 and Figure 1). Of these IAs, 48% used results exclusively or partially provided by modelling activity carried out by DG JRC. There is no clear trend in the frequency of model use, or model provider, over the period examined, and the seeming increase in the former from 2012 onwards would need to be confirmed for the years following 2014.

Table 1. Overview of IAs and model-based IAs in the period 2009-2014

Year	Number of IA	Number of model-based IA	Share of model-based IA	Number of IA with JRC involvement	Share of model-based IA with JRC involvement	Running initiatives with JRC expected involvement	Number of IA without JRC involvement
2009	83	12	0.14	10	0.83	-	2
2010	57	4	0.07	1	0.25	-	3
2011	138	21	0.15	7	0.33	-	14
2012	71	15	0.21	9	0.60	-	6
2013	104	17	0.16	6	0.35	-	11
2014	59	12	0.20	6	0.50	-	6
total	512	81	0.16	39	0.48		42

Figure 1. Overall analysis of the number of IAs, the share of IAs using models, and the share of the latter with modelling contributions of the JRC for the period 2009-2014



A closer look at the activity of each DG (Figure 2 and Figure 3) shows that DGs MARKT and ENER were the most active in terms of total IA with 9% and 25% of the total IAs, respectively, based on modelling. The DGs making most frequent use of modelling in their IAs were CLIMA (75% of the IAs), REGIO (75%) and TRADE with 50%

In terms of absolute numbers, CLIMA, ENER, ENV and MOVE account for more than half (51) of the 91 model-based IAs6. In the period under analysis, no model-based IA has been found with ECFIN as lead DG, and DGs EMPL and ENTR made use of modelling only once in 15 and 42 IAs, respectively. This is explained partly by the fact that many of the key policy activities of e.g., DGs ECFIN and EMPL, are published in reports and outlooks and are not policy initiatives.

[6] Please note that the total number of IAs by DG do not coincide with the total number of IAs of Table 1 as in some cases more DGs have been involved in the same IA. In these cases the IA is assigned to every involved DG.

Figure 2. Total number of model and non-model based IAs by DG

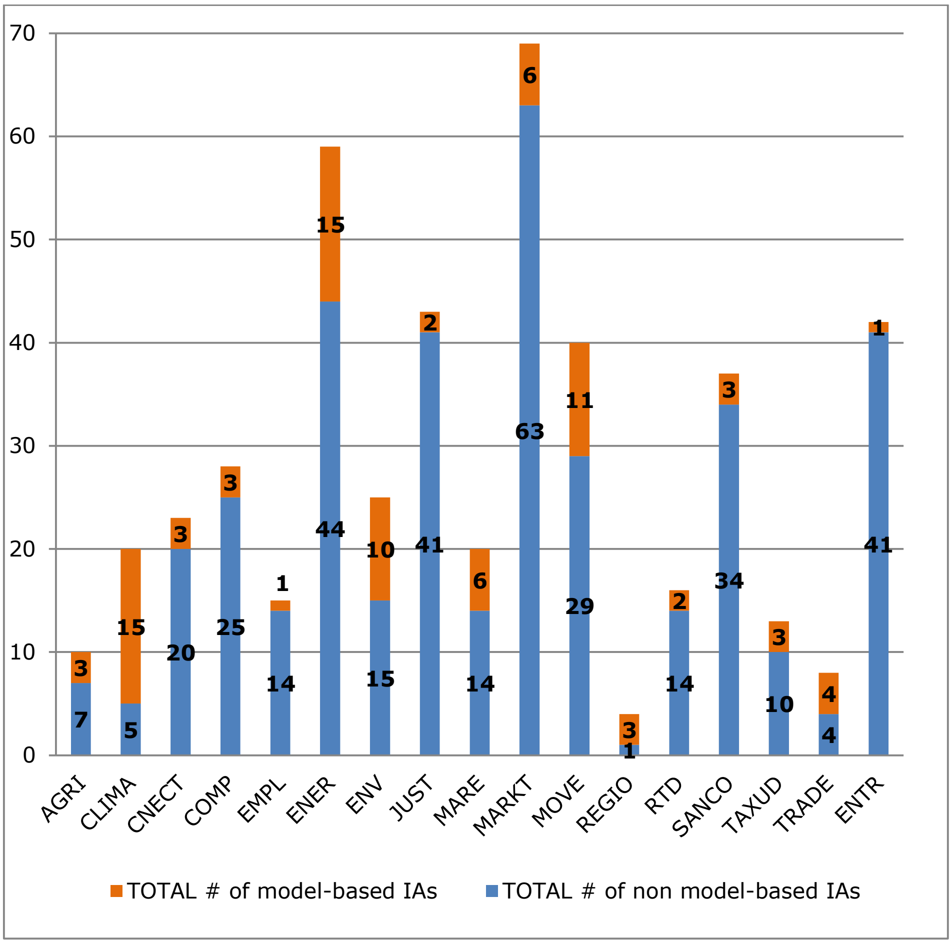
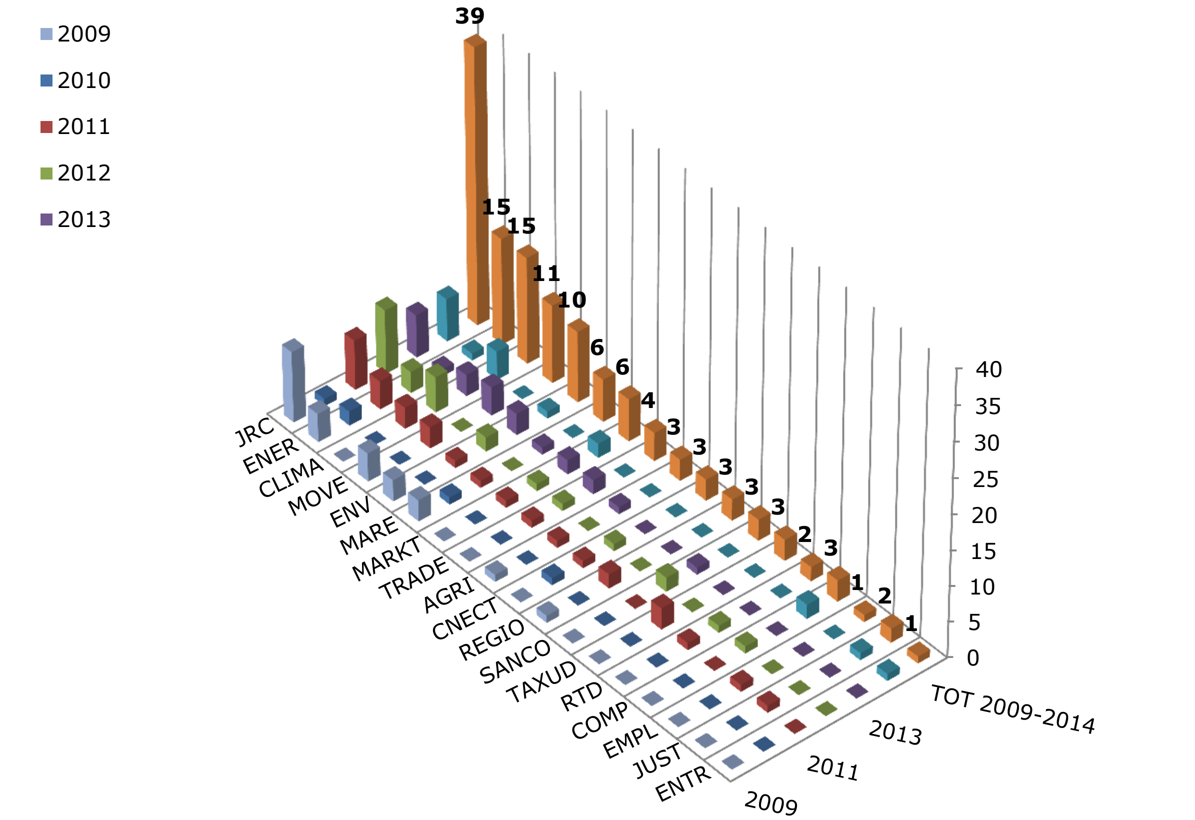


Figure 3. Number of model-based IAs by DG and by year (DGs are reordered from the most active to the least active, in terms of model-based IAs)



Note: in 2009 ENER and MOVE were merged into TREN.

Figure 3 shows the number of IAs carried out by DG and by year, with DGs reordered from most active to least active in model-based IAs.

3.2 Overview of the use of in-house versus third-party models by DG

Table 2, Figure 4 and Figure 5 detail the DG JRC contribution for each DG and each year.

Table 2. Analysis of DG JRC contribution to model-based IAs by DG and by year

DG AGRI

YEAR	# of model-based IAs	# of IAs without JRC contribution	# of IAs with JRC contribution
2009	1	0	1
2010	0	0	-
2011	1	0	1
2012	0	0	-
2013	1	1	0
2014	0	0	0
2009-2014	3	1	2

DG CLIMA

YEAR	# of model-based IAs	# of IAs without JRC contribution	# of IAs with JRC contribution
2009	0	-	-
2010	0	0	-
2011	3	2	1
2012	5	0	5
2013	3	2	1
2014	4	2	2
2009-2014	15	6	9

DG CNECT

YEAR	# of model-based IAs	# of IAs without JRC contribution	# of IAs with JRC contribution
2009	0	-	-
2010	1	1	0
2011	1	0	1
2012	1	1	0
2013	0	0	-
2014	0	0	0
2009-2014	3	2	1

DG COMP

YEAR	# of model-based IAs	# of IAs without JRC contribution	# of IAs with JRC contribution
2009	0	-	
2010	0	0	-
2011	0	0	-
2012	1	1	0
2013	0	0	-
2014	2	2	0
2009-2014	3	3	0

DG ENER

YEAR	# of model-based IAs	# of IAs without JRC contribution	# of IAs with JRC contribution
2009	4	1	3
2010	2	1	1
2011	4	2	2
2012	3	1	2
2013	1	1	0
2014	1	1	0
2009-2014	15	7	8

DG ENV

YEAR	# of model-based IAs	# of IAs without JRC contribution	# of IAs with JRC contribution
2009	3	1	2
2010	0	0	-
2011	1	1	0
2012	2	0	2
2013	3	1	2
2014	1	0	1
2009-2014	10	3	7

DG JUST

YEAR	# of model-based IAs	# of IAs without JRC contribution	# of IAs with JRC contribution
2009	0	-	-
2010	0	0	-
2011	1	1	0
2012	0	0	-
2013	0	0	-
2014	1	1	0
2009-2014	2	2	0

DG MARE

YEAR	# of model-based IAs	# of IAs without JRC contribution	# of IAs with JRC contribution
2009	3	0	3
2010	1	1	0
2011	1	1	0
2012	0	0	-
2013	1	0	1
2014	0	0	0
2009-2014	6	2	4

DG ENTR

YEAR	# of model-based IAs	# of IAs without JRC contribution	# of IAs with JRC contribution
2009	0	-	-
2010	0	-	-
2011	0	-	-
2012	0	-	-
2013	0	-	-
2014	1	0	1
2009-2014	1	0	1

DG MARKT

YEAR	# of model-based IAs	# of IAs without JRC contribution	# of IAs with JRC contribution
2009	0	-	-
2010	0	0	-
2011	1	1	0
2012	1	0	1
2013	2	1	1
2014	2	0	2
2009-2014	6	2	4

DG MOVE

YEAR	# of model-based IAs	# of IAs without JRC contribution	# of IAs with JRC contribution
2009	4	1	3
2010	0	-	-
2011	3	0	3
2012	0	0	-
2013	4	3	1
2014	0	0	0
2009-2014	11	4	7

DG REGIO

YEAR	# of model-based IAs	# of IAs without JRC contribution	# of IAs with JRC contribution
2009	1	0	1
2010	0	0	-
2011	2	2	0
2012	0	0	-
2013	0	0	-
2014	0	0	0
2009-2014	3	2	1

DG RTD

YEAR	# of model-based IAs	# of IAs without JRC contribution	# of IAs with JRC contribution
2009	0	-	-
2010	0	0	-
2011	1	0	1
2012	1	1	0
2013	0	0	-
2014	0	0	0
2009-2014	2	1	1

DG SANCO

YEAR	# of model-based IAs	# of IAs without JRC contribution	# of IAs with JRC contribution
2009	0	-	-
2010	0	0	-
2011	0	0	-
2012	2	1	1
2013	1	0	1
2014	0	0	0
2009-2014	3	1	2

DG TAXUD

YEAR	# of model-based IAs	# of IAs without JRC contribution	# of IAs with JRC contribution
2009	0	-	-
2010	0	0	-
2011	3	3	0
2012	0	0	-
2013	0	0	-
2014	0	0	0
2009-2014	3	3	0

DG TRADE

YEAR	# of model-based IAs	# of IAs without JRC contribution	# of IAs with JRC contribution
2009	0	-	-
2010	0	0	-
2011	1	1	0
2012	1	1	0
2013	2	2	0
2014	0	0	0
2009-2014	4	4	0

DG EMPL

YEAR	# of model-based IAs	# of IAs without JRC contribution	# of IAs with JRC contribution
2009	0	-	-
2010	0	-	-
2011	1	1	0
2012	0	-	-
2013	0	-	-
2014	0	-	-
2009-2014	1	1	0

Figure 4. Analysis of DG JRC contribution to model-based IAs by DG and by year

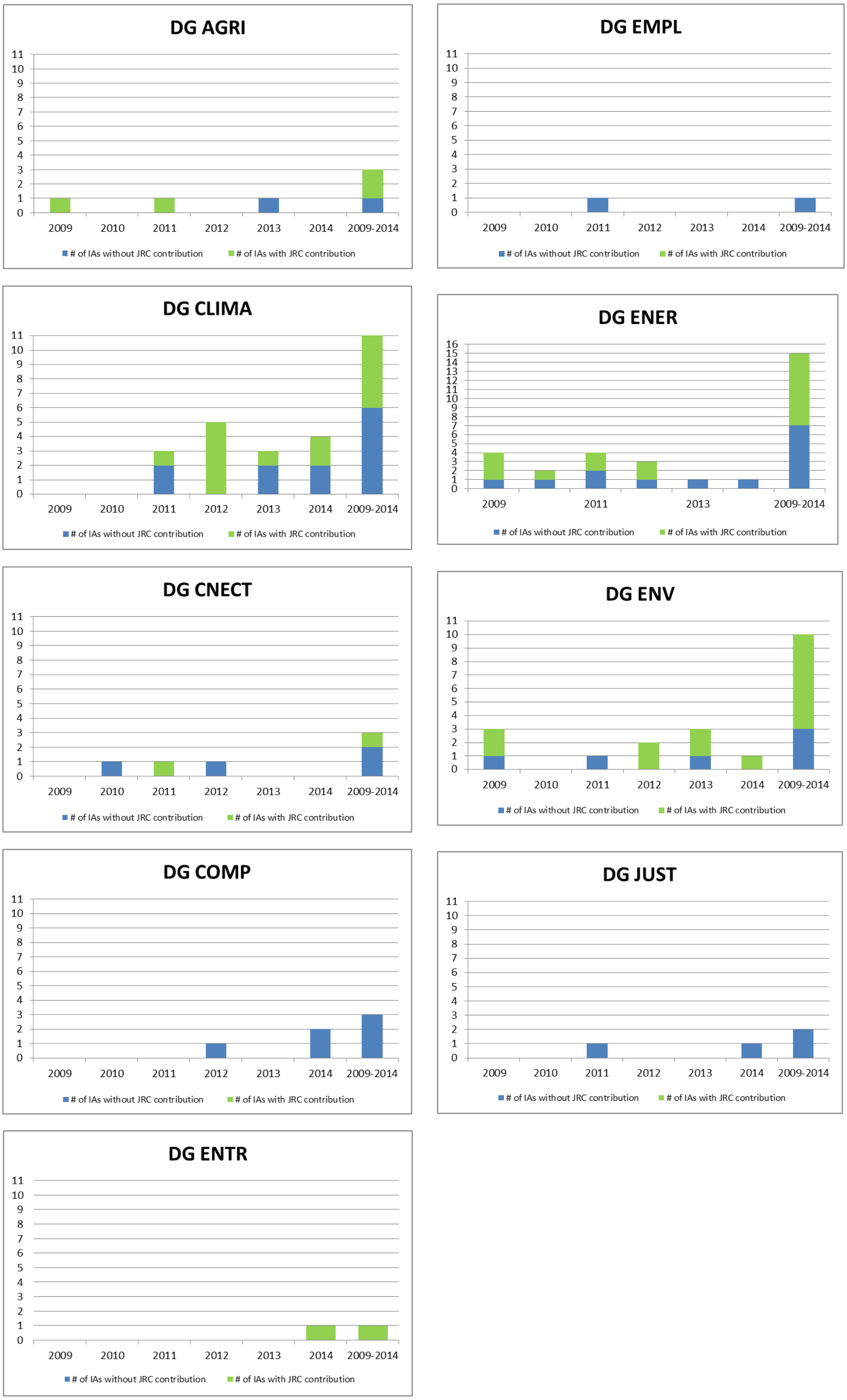
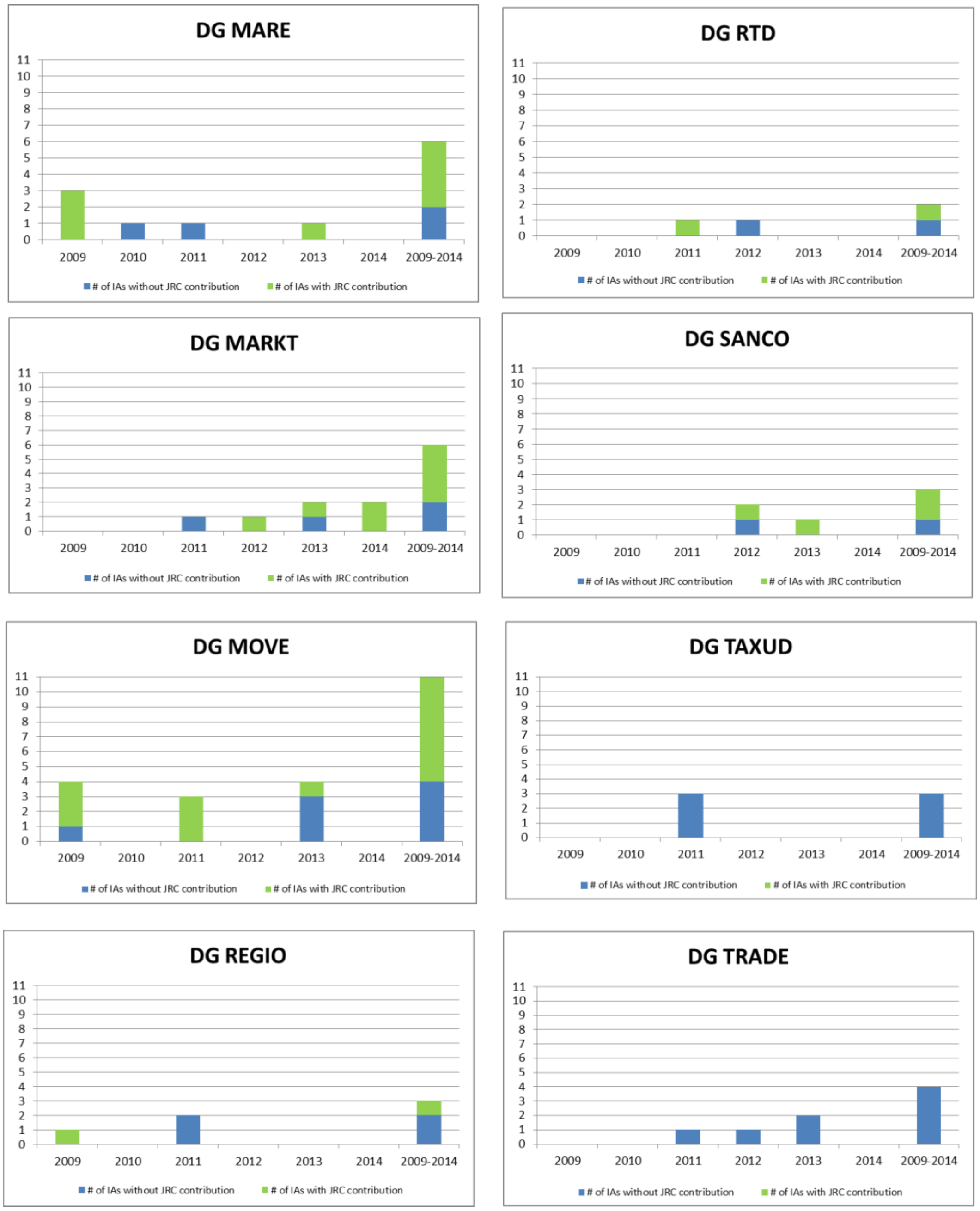


Figure 5. Analysis of DG JRC contribution to model-based IAs by DG and by year (continued)



Over the years, CLIMA, ENER, MOVE, ENV, MARKT and MARE were the DGs that made most use of in-house (DG JRC) modelling support. For the period in question, and on the basis of the published IA reports, it appears that DGs COMP, JUST, TRADE7 , EMPL and TAXUD did not make use of the in-house models (DG JRC). These latter DGs, with the exception of TRADE, are not among the most active ones in terms of model-based IA.

3.3 Results by model

To complete the analysis, we searched for the most frequently-used models. The analysis is split in two parts:

[7] It should be noted that Impact Assessments for (some) trade agreements are not public.

1. One-way frequency analysis of the models used for model-based IAs;

2. Two-way frequency analysis to associate each model to the lead DGs which used it.

Small discrepancies can be present between the two analyses in the counting of models due to the involvement of multiple lead DGs for the same IA.

When it was not possible to clearly identify the name of the model used, we opted for a generic label, like for example "econometric modelling" or "CGE". It must be noted that in the GTAP case, the name "GTAP" is sometimes associated to a database and other times to a static general equilibrium model. In our analysis, GTAP is counted as a model only if the IA documents clearly mention the use of GTAP as a model.

3.3.1 Frequency by model

Results of the one-way statistical analysis are shown in Table 3 which displays the absolute frequency of use of a model and the number of times the model has been run in-house or by "third-party".

In total, 91 different models have been used at least once for a model-based IA in the period under analysis.

Models have been used in 263 cases, out of which 70 cases made use of DG JRC modelling support (about 27% of the cases; see Table 3). 8

Figure 6 shows the most-frequently used models. Models used only once in the reference period are grouped together and labelled "one-time models". It is worth noting that the "one-time models" group includes 55 models out of 91, meaning that most models (60%) have been used only once. This suggests a high level of fragmentation of modelling needs and activity in the IA analysis carried out by the EC, even taking into account that some of these models are very recent (e.g. FIDELIO, RHOMOLO).

The most frequently-used model is by far PRIMES, used in 28 out of 263 cases (about 11% of the cases). This is followed by 10 other models which are used exclusively or predominantly with PRIMES in the context of the energy-climate scenarios (GEM-E3, TREMOVE, CAPRI, POLES, G4M, GAINS, GLOBIOM, LUISA, PROMETHEUS and TRANSTOOLS). The use of these models and platform-model/s jointly accounts for about 48% of the cases.

Another well-known energy model, E3ME ranks at the 9th position in term of most frequently-used model. This econometric model has been used by a contractor for several policy DGs - CLIMA, ENER, ENV, MOVE and TAXUD.

The most frequently-used models in the period under analysis are all energy-transport-climate (Greenhouse Gas emissions) models. QUEST and SYMBOL, both used for IAs related to the economic and monetary union, closely follow.

In the transport area, the most frequently-used model is TREMOVE. This is presumably because of its close link, and often joint use, with PRIMES.

The most frequently-used in-house models (of the DG JRC), listed in Table 3, are energy models - GEM-E3 and POLES - followed by environmental models – the LUISA modelling platform and LISFLOOD, the micro-economic model for financial markets SYMBOL, the transport model TRANSTOOLS and the agricultural models belonging to the iMAP platform - CAPRI and AGLINK-COSIMO. Other DG JRC models (e.g BioMA, ESIM, FASST, FIDELIO, GLOBE, Infra-CCS, LULUCF tool, MC-GENERCIS, Model-T, PESERA, RHOMOLO, RURAL-ECMOD, TIMES-EU) have been used only once.

[8] Some of the models are used by both the JRC and external contractors (e.g., GEM-E3, POLES), sometimes for different purposes (e.g., CAPRI for emissions from agriculture – external contractor; CAPRI for agricultural markets – DG JRC). This has been duly taken into account.

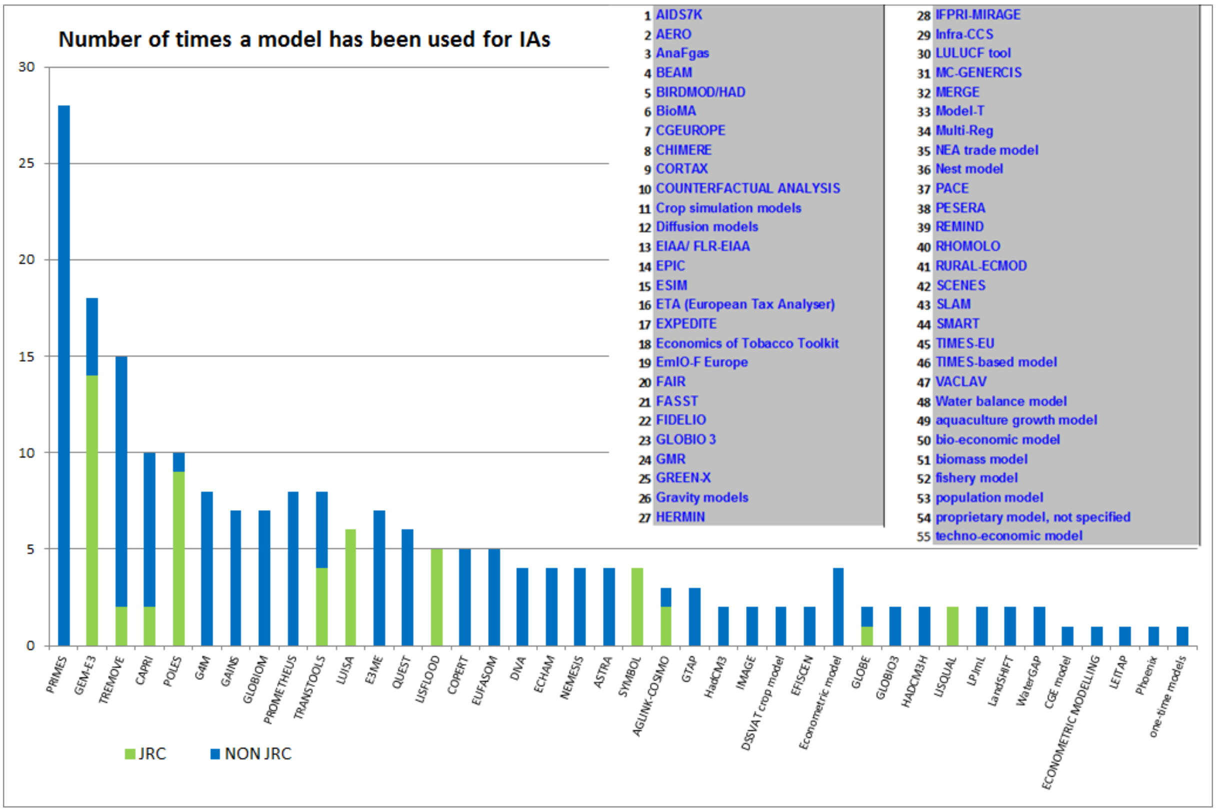
Table 3. Number of times a model was used for an IA (as a total as well as by differentiating between 'run in-house' and 'third-party' use for the particular impact assessment). Models are listed in alphabetic order

MODEL	Frequency	JRC	NON JRC		MODEL	Frequency	JRC	NON JRC
AIDS7K	1	0	1		HERMIN	1	0	1
AERO	1	0	1		IFPRI-MIRAGE	1	0	1
AGLINK-COSIMO	3	2	1		IMAGE	2	0	2
ASTRA	4	0	4		Infra-CCS	1	1	0
AnaFgas	1	0	1		LEITAP	1	0	1
BEAM	1	0	1		LISFLOOD	5	5	0
BIRDMOD/HAD	1	0	1		LISQUAL	2	2	0
BioMA	1	1	0		LPJmL	2	0	2
CAPRI	10	2	8		LUISA	6	6	0
CGE model	1	0	1		LULUCF tool	1	1	0
CGEUROPE	1	0	1		LandSHIFT	2	0	2
CHIMERE	1	0	1		MC-GENERCIS	1	1	0
COPERT	5	0	5		MERGE	1	0	1
CORTAX	1	0	1		Model-T	1	1	0
COUNTERFACTUAL ANALYSIS	1	0	1		Multi-Reg	1	0	1
Crop simulation models	1	1	0		NEA trade model	1	0	1
DIVA	4	0	4		NEMESIS	4	0	4
DSSVAT crop model	2	0	2		Nest model	1	0	1
Diffusion models	1	0	1		PACE	1	0	1
E3ME	7	0	7		PESERA	1	1	0
ECHAM	4	0	4		POLES	10	9	1
ECONOMETRIC MODELLING	1	0	1		PRIMES	28	0	28
EFISCEN	2	0	2		PROMETHEUS	8	0	8
EIAA/ FLR-EIAA	1	0	1		Phoenix	1	0	1
EPIC	1	0	1		QUEST	6	0	6
ESIM	1	1	0		REMIND	1	0	1
ETA (European Tax Analyser)	1	0	1		RHOMOLO	1	1	0
EUFASOM	5	0	5		RURAL-ECMOD	1	1	0
EXPEDITE	1	0	1		SCENES	1	0	1
Econometric model	4	0	4		SLAM	1	0	1
Economics of Tobacco Toolkit	1	0	1		SMART	1	0	1
EmIO-F Europe	1	0	1		SYMBOL	4	4	0
FAIR	1	0	1		TIMES-EU	1	1	0
FASST	1	1	0		TIMES-based model	1	0	1
FIDELIO	1	1	0		TRANSTOOLS	8	4	4
G4M	8	0	8		TREMOVE	15	2	13
GAINS	7	0	7		VACLAV	1	0	1
GEM-E3	18	14	4		Water balance model	1	1	0
GLOBE	2	1	1		WaterGAP	2	0	2
GLOBIO3	2	0	2		bio-economic model	1	1	0
GLOBIOM	7	0	7		biomass model	1	1	0
GMR	1	0	1		fishery model	1	1	0
GREEN-X	1	0	1		population model	1	1	0
GTAP	3	0	3		proprietary model, not specified	1	0	1
Gravity models	1	0	1		techno-economic model	1	0	1
HADCM3H	2	0	2		TOTAL	263	70	193
HadCM3	2	0	2					

Table 4. Ranking of DG JRC-run models

MODEL	Frequency
GEM-E3	**14**
POLES	**9**
LUISA	6
LISFLOOD	5
SYMBOL	4
TRANSTOOLS	**4**
AGLINK-COSIMO	2
CAPRI	2
LISQUAL	2
BioMA	1
Crop simulation models	1
ESIM	1
FASST	1
FIDELIO	1
GLOBE	1
Infra-CCS	1
LULUCF tool	1
MC-GENERCIS	1
Model-T	1
PESERA	1
RHOMOLO	1
RURAL-ECMOD	1
TIMES-EU	1
TREMOVE	**2**
Water balance model	1
aquaculture growth model	1
bio-economic model	1
biomass model	1
fishery model	1
population model	1

Figure 6. Absolute frequency of model use in IAs in the period 2009-2014.
In green the number of cases where models have been run under DG JRC responsibility.



3.3.2 Model use in different policy areas

The two-way frequency analysis highlights the DGs use for models in IAs. Table 5 shows the models used by each DG. Models are reordered from the most frequently used and those used at least 3 times by a DG are highlighted.

Table 5. Models used by DG. Models used at least 3 times by one DG are highlighted

	AGRI	CLIMA	CNECT	COMP	EMPL	ENER	ENV	JUST	MARE	MARKT	MOVE	REGIO	RTD	SANCO	TAXUD	TRADE	Total
PRIMES	0	**7**	1	1	0	**11**	**4**	0	0	0	**7**	0	0	0	1	0	32
GEM-E3	0	**5**	1	0	0	**4**	**5**	0	1	0	**4**	1	0	0	0	0	21
TREMOVE	0	**5**	1	0	0	**3**	2	0	0	0	**6**	0	0	0	1	0	18
TRANSTOOLS	0	1	1	0	0	**4**	0	0	0	0	**6**	0	0	0	0	0	12
POLES	0	**3**	0	0	0	**4**	**3**	0	0	0	2	0	0	0	0	0	12
CAPRI	2	**4**	0	0	0	1	2	0	0	0	1	0	0	0	0	0	10
G4M	0	**4**	0	0	0	1	1	0	0	0	1	0	0	1	0	0	8
GAINS	0	2	1	0	0	2	**3**	0	0	0	1	0	0	0	0	0	9
PROMETHEUS	0	2	1	0	0	**4**	0	0	0	0	**3**	0	0	0	0	0	10
LUISA	1	1	0	0	0	1	**4**	0	1	0	0	0	0	0	0	0	8
E3ME	0	1	0	0	0	**3**	2	0	0	0	1	0	0	0	1	0	8
GLOBIOM	0	**4**	0	0	0	1	1	0	0	0	1	0	0	0	0	0	7
QUEST	0	0	0	0	1	0	0	0	0	**3**	0	1	0	0	2	0	7
ASTRA	0	0	0	0	0	2	1	0	0	0	1	1	0	0	0	0	5
COPERT	0	0	0	0	0	1	2	0	0	0	2	0	0	0	1	0	6
EUFASOM	0	**3**	0	0	0	1	0	0	0	0	1	0	0	1	0	0	6
LISFLOOD	0	1	0	0	0	0	**3**	0	1	0	0	1	0	0	0	0	6
NEMESIS	0	0	0	0	0	1	0	0	0	1	0	1	2	0	0	0	5
DIVA	0	1	0	0	0	0	2	0	1	0	0	1	0	0	0	0	5
ECHAM	0	1	0	0	0	0	2	0	2	0	0	0	0	0	0	0	5
AGLINK-COSIMO	1	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	4
ECONOMETRIC MODELLING	0	0	0	0	0	0	0	1	0	0	0	2	0	0	0	2	5
GTAP	0	0	0	0	1	0	0	1	0	0	0	1	0	0	0	1	4
SYMBOL	0	0	0	0	0	0	0	0	0	**4**	0	0	0	0	0	0	4
EFISCEN	0	2	0	0	0	0	0	0	0	0	0	0	0	1	0	0	3
HadCM3	0	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0	3
IMAGE	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0	0	3
LISQUAL	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	3
CGE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2
CGEUROPE	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	2
DSSVAT crop model	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	2
EXPEDITE	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	2
GLOBE	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	2
GLOBIO 3	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	2
GLOBIO3	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	2
GMR	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	2
HADCM3H	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	2
HERMIN	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	2
IFPRI-MIRAGE	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	2
LEITAP	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	2
LPJmL	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2
LandSHIFT	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2
MC-GENERCIS	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	2
NEA trade model	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	2
Phoenix	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	2
SCENES	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	2
SLAM	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	2
TIMES-EU	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	2
VACLAV	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	2
WaterGAP	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2
AIDS7K	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
AERO	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
AnaFgas	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BEAM	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
BIRDMOD/HAD	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
BioMA	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
CHIMERE	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
CORTAX	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
COUNTERFACTUAL ANALYSIS	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
Crop simulation models	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Diffusion models	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
EIAA/ FLR-EIAA	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
EPIC	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
ESIM	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
ETA (European Tax Analyser)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Economics of Tobacco Toolkit	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
EmIO-F Europe	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
FAIR	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
FASST	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
FIDELIO	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
GREEN-X	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
Gravity models	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Infra-CCS	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
LULUCF tool	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
MERGE	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
Model-T	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
Multi-Reg	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
Nest model	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
PACE	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
PESERA	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
REMIND	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
RHOMOLO	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
RURAL-ECMOD	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
SMART	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
TIMES-based model	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Water balance model	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
aquaculture growth model	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
bio-economic model	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
biomass model	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
fishery model	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
population model	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
proprietary model, not specified	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
techno-economic model	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Total	10	61	8	2	4	62	57	2	18	8	45	15	3	5	8	8	316

3.4 Preliminary results

The present results agree with those published by the LIAISE consortium (Jansen J., van Itterum M., Jansen S., Reidsma, P., Integrated assessment of agricultural systems at the European level, 2016), in terms of the number of cases of IAs with model use, the actual models used, and their frequency, where the present study focusses rather on the use of external versus in-house models.

The IAs reflects, in the period investigated, largely the EU2020 strategy and the policy response to the economic crisis, both in terms of the numbers of IAs (policy proposals) and their contents. The two areas with the highest number of IAs (both with and without modelling) are the low-carbon economy and the internal market.

3.4.1 The low-carbon economy

The policy area with the highest use of models for IAs is the field of low carbon economy, with DGs CLIMA, ENER and MOVE accounting for 41 out of 91 (45%) model-based IAs9. In this area, the energy-climate reference scenario is being used since 2011 for all long-term initiatives of the Commission since 2011 (before this, this role was essentially fulfilled by the "energy trends" studies using a subset of the models indicated below). In 2011, the energy reference scenario was developed with a model portfolio consisting of the following models: PRIMES, PROMETHEUS, GAINS, G4M, GLOBIOM, GEM-E3, POLES, EUFASOM and CAPRI. The energy reference scenario forms the backbone of the IAs, for example the Roadmap for moving to a Low-Carbon Economy in 2050 (COM(2011) 112), the Energy Roadmap 2050 (COM(2011) 885) and the White Paper on Transport (COM(2011) 144). In the latter, the model portfolio was extended by TRANSTOOLS, TREMOVE and COPERT to deal with transport-related issues. Further policy proposals, such as the Energy Efficiency Plan 2011, make substantially use of, or mention at least single values of, the energy reference scenario. In total, the energy reference scenario was cited in 13 different IAs between 2011 and 2013.

In addition, we found a number of IAs using stand-alone models for specific cases. To deal with the evaluation of an inclusion of aviation in the Emissions Trading System (ETS), the AERO model was applied. A TIMES-based model was used for a proposal on carbon emission from maritime transport. Furthermore, there is a high number of IAs on eco-design and eco-labelling, in which small diffusion models developed by external consultants were applied. These models were not counted in our analysis and this explains in part the relatively lower proportionate use of models in IA by DG ENER compared with DGs CLIMA and MOVE.

The model use per DG reflects the model portfolio of the energy reference scenario (Table 5). PRIMES and GEM-E3 are among the most frequently-used models by DGs CLIMA, ENER and MOVE. In addition, we found for DG CLIMA a high use of climate and emission models: G4M, GLOBIOM, EUFASOM and CAPRI. Also these DGs often applied the POLES model to derive global emissions. In the IAs for DG ENER, we found next to PRIMES and GEM-E3 the highest use for the statistical energy model PROMETHEUS, which is developed and applied by the same provider as PRIMES.

DG JRC develops and maintains a number of models in the field of low-carbon economy. GEM-E3 is the model which was most often applied by DG JRC in this field (Table 4). GEM-E3 covers economy, energy and environment. It is mainly used for either GDP projections on a sector level or for analysing the economic impacts (competitiveness) of climate policies on sectors such as the energy-intensive industry. In the frame of the Energy Reference Scenario, the EC makes use of GEM-E3 both through mostly the National Technical University of Athens (NTUA) (and, in earlier years, DG JRC). While GEM-E3 is widely used for DG CLIMA, DG ENER and DG MOVE, POLES is mainly applied in IAs of DG CLIMA. POLES estimates energy supply and demand on a global level and

[9] Please note that in the analysis by DG, an IA can be counted more than ones if more than one DG has been involved in that IA.

derives global emissions; this is the reason for its often complementary use to a more detailed energy-emission model on the EU level (PRIMES).

E3ME has been used 7 times in IAs over the period investigated.

In summary, the Energy Reference Scenario is the model-based IA which has been most frequently used for policy-making purposes. This scenario is essentially provided by an outside consortium, with limited contribution from DG JRC in earlier years on estimates of global energy demand and supply and global emissions (POLES).

DG JRC contributed to the IAs accompanying many of the key policy proposals, such as the Low Carbon Economy in 2050, the Energy Roadmap 2050 and the 2030 Climate and Energy Framework, but had a minor role compared to that of the contractors providing the models for the Energy Reference Scenario. On important fields like energy efficiency (e.g. Energy Efficiency Plan 2011) and the Emissions Trading Scheme (e.g. on inclusion of aviation), DG JRC did not contribute with modelling within the considered time period. However, DG JRC applied the GEM-E3 in the Communication on fluorinated greenhouse gases (COM (2012) 643), the TIMES-EU model in the Communication on hydraulic fracturing (COM (2014) 23) and contributed to the communication on renewable energy (COM (2012) 271). To be noted that the major modelling contributions to the IA on hydraulic fracturing, namely on energy markets, was done by an outside contractor with POLES and E3ME.

As regards transport, a number of transport models have been used which are linked with the model portfolio of the energy reference scenario. These transport models are: TRANSTOOLS (transport network), TREMOVE (emissions) and COPERT (vehicle emission).

TRANSTOOLS was developed by a consortium led by the Danish Technical University (DTU). The development was funded in collaborative projects by DG MOVE and DG JRC. DG JRC is coordinating the further development of the model and applied the TRANSTOOLS model in the White Paper. Further contributions (e.g. TEN-T guidelines) of TRANSTOOLS to IAs were carried out by external contractors. TREMOVE is also widely used in IAs related to emissions of transport by external providers. DG JRC has contributed to the White Paper of Transport by applying and analyzing the results of TRANSTOOLS. Within the area of emissions of transport, DG JRC contributed to a Communication on CO2 emission targets of road vehicles (COM (2012) 393), but neither on emissions of maritime transport nor on aviation. JRC also did not contribute to the regulations of the TEN-T guidelines.

The internal vs external use of TRANSTOOLS is a complex issue linked in part to the development of the model itself. DG JRC is currently working, at the request of DG MOVE, on a simplified version of TRANSTOOLS which may lead to greater use of an in-house version.

3.4.2 The environmental sector

The most frequently-used models in the environmental sector are those used in the suite for the Energy Reference Scenario, as it was also in the case of the low-carbon economy. The frequent use of the emissions model GAINS can be understood from its application to air pollution (environment) as well as to GHG emissions (climate).

Next to the models used for the low-carbon economy, the environmental models are those most frequently used. Among the frequently-used models, DG JRC has developed the Land Use-based Integrated Sustainability Assessment (LUISA) modelling platform10, used in 7 cases. Other frequently-used and DG JRC-developed models are LISFLOOD (6 cases) and LISQUAL (2 cases).

[10] Recently, the Land Use Modelling Platform (LUMP) was re-named as the Land Use-based Integrated Sustainable Assessment (LUISA) modelling platform.

The DG JRC has contributed with its environmental models to the IAs of some of the major policy proposals of DG ENV, DG CLIMA and DG AGRI:

In 2011, within the IA for the Common Agricultural Policy (CAP) towards 2020, LUISA modelling platform was employed to assess a range of environmental impacts as a result of the implementation of different policy options foreseen under the CAP reform, particularly focusing on the greening component of direct payments.

In the context of the IA for the Blueprint to Safeguard Europe's Water resources (2012), a modelling environment has been developed to assess optimum combinations of water retention measures, water savings measures, and nutrient reduction for Europe. This modelling environment includes and links several models, among which LISFLOOD, LISQUAL and LUISA platform modelling. In particular, LUISA played a key role in the development of a baseline scenario bringing together climate, land-use and socio-economic scenarios and looking at the implication for water resources availability and use under different policy scenarios.

In 2013, the DG JRC PESETA II project was used in the IA of 'An EU Strategy on adaptation to climate change' to assess the economic effects of climate-related risks. LUISA platform modelling was employed to estimate the impacts of climate change and examine the adaptation measures in Europe in the Horizon 2020, compared to the reference situation of no climate change. Some calculations are based on the model LISFLOOD with population projections from SCENES scenarios (SWD (2013) 132 final; COM (2013) 216 final).

In the IA for 'Maritime spatial planning and integrated coastal management', LUISA platform modelling provided estimates of policy alternatives impacts on European coastal zones.

As regards the IA of the air quality package, FASST was used to model GHG emission between 1990 and 2030 , as a complement to the assessment by the GAINS model which does not cover the global domain (SWD (2013) 531). FASST has also been used to evaluate air quality co-benefits of climate policies at a global scale, again as a complement to GAINS.

Likewise, in 2014, within the IA for the 'Exploration and production of hydrocarbons (such as shale gas) using high volume hydraulic fracturing in the EU' (2014), case studies were conducted on the impact on land and water use in Poland and Germany by using LUISA platform modelling and LISQUAL model.

3.4.3 The internal market

As regards the internal market, two main points can be noted. First, it is the area with the highest total number of IAs, but with a very low proportion of the use of modelling. Second, the two models, QUEST and SYMBOL, are used essentially in the context of the economic and monetary union. SYMBOL, which has been developed since 2012 by the JRC in cooperation with DG MARKT, has established itself as a reference tool to assess the impact of new financial regulation due to its timely availability in the aftermath of the financial crisis, its flexibility and relatively simple structure. DG ECFIN has developed its standard general equilibrium model (QUEST) in analogy to what has been done by other financial institution and bodies at national and supranational levels and DG JRC contributes regularly to the calibration of QUEST, providing estimates of the model parameters. SYMBOL and QUEST might be considered, for certain aspects, complementary (e.g. in the cumulative IA edited by DG MARKT, SYMBOL has been used to assess the global benefits of selected newly introduced financial regulations, while QUEST has been used to estimate their macroeconomic costs). This is a good example of the synergy that can be reached integrating different models in assessing the impacts of political reforms.

As regards DG TRADE, while the total number of IAs is low, the proportion of model-based IAs is high (Fig. 2 and Table 2). A variety of models have been used for the analysis of the economic impacts of trade agreements (GLOBE, GTAP, Gravity Models, unnamed proprietary models) (Table 4). From the DG TRADE web site of published "trade sustainability assessments", it can be seen that ECORYS is the most frequently called-on contractor.

3.4.4 The agricultural sector

In the policy area of agriculture, 3 out of 10 IAs launched by DG AGRI during the studied period were model-based (in total 9 models were used). Most of the models (7) were used for the IA of the CAP reform. The 2013 CAP reform is considered to be the most important policy regulatory change in agriculture since 2009. DG JRC used its Integrated Modelling Platform for Agro-economic Commodity and Policy Analysis (iMAP) to support the IA.11 The platform iMAP is composed of quantitative tools (such as CAPRI, AGLINK-COSIMO, ESIM, RURAL-ECMOD) used for economic assessment of agriculture and related policies (rural development, trade, energy, environment and climate change etc.) as well as of a comprehensive data management system. In addition to the agricultural models, the IA made use of the EUClueScanner (key model of LUISA) and PESERA models that are used for EU-wide land use and soil erosion assessments, respectively.

As regards agricultural policies, the most frequently-used models are run by DG JRC: CAPRI 12(twice by DG AGRI) and AGLINK-COSIMO (once by DG AGRI). In these two instances, the applications of these two models were for the IA of the CAP reform, trade and agri-environmental policies. CAPRI, partially developed by DG JRC, is the key agro-economic model of the EC. AGLINK-COSIMO is used for the construction of baseline scenarios – the annual EU Agricultural Outlook – for DG AGRI and therefore plays a central role in commodity and policy analysis of the EC.

3.4.5 Regional Policies

There were only three model-based IAs published by DG REGIO in the period investigated. One is for the EU strategy for the Baltic Sea, with environmental impacts being modelled with NEST (impact of the Water Framework Directive) and using the results of PESETA II (essentially GEM-E3 and LISFLOOD). The second concerns regulations (general and specific provisions) for the structural instruments covered by the Common Strategic Framework 2014-2020. For the regulation on the contribution of the European Regional Development Fund (ERDF) to territorial cooperation goals, the specific work undertaken is essentially an ex-post evaluation of the impact of the ERDF in certain regions (using econometric modelling). Here, the IA quotes principally the impact on GDP and employment of the energy efficiency goals for 2020 (third-party models NEMESIS and ASTRA). For the more general provisions, an ex-post evaluation using HERMIN, QUEST, GTAP and GMR was used (with all but QUEST being third-party models).

One of the reasons for the seemingly low use of modelling in regional policies is that a key policy instrument is the periodic cohesion report which contains both an ex-post evaluation and ex-ante impact assessment and hence makes extensive use of modelling.

3.4.6 Employment Policies

DG EMPL was the lead DG in 14 IAs, only one of which made use of models. This concerns the regulation on the structural funds for 2014-2020 (see above) in which employment effects are extensively discussed.

[11] SWD(2011) 1154: Proposal for a Regulation establishing rules for direct payments to farmers under support schemes within the framework of the common agricultural policy (CAP towards 2020).

[12] CAPRI was developed by a consortium of 10 research organisations from 7 EU countries and Turkey under the 7th Framework Programme for Research. There are different versions of CAPRI, among which one used by external contractors (EUROCARE, ILR) in the context of the energy-climate reference scenario and air quality and the one used for the agricultural sector by DG JRC. CAPRI is hosted now by the University of Bonn.

4 Conclusions and outlook

- The scope of the present analysis does not allow drawing conclusions as to whether the overall proportion of model use (16% of all impact assessment) is appropriate. However, some conclusions can be drawn as to the strategic position of the EC's in-house model portfolio.
- For one of the central scenarios of EC policy making, namely the energy –climate reference scenario, the EC depends on external contractors who run a suite of models. There are ongoing efforts to reduce this dependency (for example through development of an energy market model (POTEnCIA), a related transport model (through a call under the Framework Programme for Resesearch), and agriculture and forestry models (further extension of CAPRI to include all GHG, extension of the Carbon-budget model to include economic aspects).
- The EC's needs in the area of the Economic and Monetary Union appear to be covered by in-house models (QUEST and SYMBOL) and their further developments.
- In environmental policies, there is a wide range of models being used. DG ENV is currently carrying out a study to analyse the need for, and availability of, models in the frame of the 7th Environmental Action Plan.
- For regional policies, an ongoing in-house model development (RHOMOLO) is meant to largely answer the needs for regional economic analysis, in combination with spatially disaggregated sectorial models (e.g., for transport) and a land-use model (LUISA platform).
- In the area of taxation and employment, the EC has so far relied on third-party models (except for QUEST). Further development of a model for fiscal/employment effects of taxation policies is ongoing (EUROMOD, initially developed through a service contract).
- For agricultural policies, the EC appears to be well positioned in the area of agricultural markets, global energy markets and some areas of the environment (water and land use). Nevertheless, given current policy developments (greening of the CAP, GHG emissions from agriculture), continuing adaptation of the models seems to be called for.

In a number of sectors, the current findings are conditioned by the particularity of the policy cycle. For example, DG AGRI's major IA making extensive use of (DG JRC) models is the CAP and its reforms, on a 5-year cycle. For DG REGIO, a major output making extensive use of modelling are the Cohesion Reports (on a 6-year cycle) which do not figure in the current list as they are not policy proposals. In order to obtain a more complete overview of Commission (modelling) output, the kind of analysis presented here should be extended to major mandatory reports and ex-post evaluations. However, there is currently no obvious information source for such reports.

In order to address the current lack of some strategic models, the important investment in answering some of these gaps, and the large amount of models being used for EC policy making (even if the number of frequently-used models is much more limited), it would be useful to obtain a more systematic and strategic view of policy needs for modelling, gaps in the ECs model portfolio and a plan to address them. Furthermore, the large number of (sectorial) models used across different policy areas and the need to ensure policy coherence would call for attention to ensure consistency in data, assumptions and baselines across the relevant policy areas of the EC.

DG JRC is currently exploring whether a Competence Centre on modelling would provide the foundation of a more coherent and strategic approach to the use of modelling in the EC.

References

Jansen J., van Itterum M., Jansen S., Reidsma, P., Integrated assessment of agricultural systems at the European level, 2016 (http://www.wur.nl/upload_mm/c/f/3/6f3b0caa-bf89-40a5-a0d9-0f9c5ad87cf5_Policy_brief_final_A.pdf)

Impact Assessments used for the report at:

http://ec.europa.eu/smart-regulation/impact/ia_carried_out/cia_2009_en.htm

http://ec.europa.eu/smart-regulation/impact/ia_carried_out/cia_2010_en.htm

http://ec.europa.eu/smart-regulation/impact/ia_carried_out/cia_2011_en.htm

http://ec.europa.eu/smart-regulation/impact/ia_carried_out/cia_2012_en.htm

http://ec.europa.eu/smart-regulation/impact/ia_carried_out/cia_2013_en.htm

http://ec.europa.eu/smart-regulation/impact/ia_carried_out/cia_2014_en.htm

List of abbreviations and definitions

Model definition

Model	A model is a set of mathematical concepts and language to simulate and describe the behaviour of a (economic, environmental, biological, physical, etc.) system composed by entities and their mutual interactions. In general all models have an information input, and an output of estimated results.

The names (acronyms) of DGs for:

AGRI	Agriculture and Rural Development
CLIMA	Climate Action
CNECT	Digital Single Market
COMP	Competition
ENTR	Enterprise and Industry
EMPL	Employment, Social Affairs & Inclusion
ENER	Energy
ENV	Environment
JRC	Joint Research Centre
JUST	Justice and Consumers
MARE	Maritime Affairs and Fisheries
MARKT	Internal Market and Services
MOVE	Mobility and Transport
REGIO	Regional and Urban Policy
RTD	Research & Innovation
SANCO	Health and Food Safety
TAXUD	Taxation and Customs Union
TRADE	Trade

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Annex

Information on the most frequently-used models

AGLINK-COSIMO: http://agrilife.jrc.ec.europa.eu/AGLINK.htm

CAPRI: http://www.ilr.uni-bonn.de/agpo/rsrch/capri/capri_e.htm

E3ME:http://www.camecon.com/EnergyEnvironment/EnergyEnvironmentEurope/ModellingCapability/E3ME.aspx

G4M: http://www.iiasa.ac.at/web/home/research/modelsData/G4M.en.html

GAINS: http://gains.iiasa.ac.at/models/

GEM-E3: https://ec.europa.eu/jrc/en/gem-e3/model

GLOBIUM: http://www.globiom.org/

LISFLOOD: http://publications.jrc.ec.europa.eu/repository/handle/JRC45143

LUISA: https://ec.europa.eu/jrc/en/luisa

QUEST: http://ec.europa.eu/economy_finance/research/macroeconomic_models_en.htm

PRIMES:http://www.e3mlab.ntua.gr/e3mlab/index.php?option=com_content&view=category&id=35&Itemid=80&lang=en

POLES:https://ec.europa.eu/jrc/en/scientific-tool/poles-prospective-outlook-long-term-energy-systems

PROMETHEUS: http://www.e3mlab.ntua.gr/e3mlab/

SYMBOL: http://publications.jrc.ec.europa.eu/repository/handle/JRC77215

TRANSTOOLS: http://energy.jrc.ec.europa.eu/transtools/TT_model.html

TREMOVE: www.tremove.org

KJ-NA-28628-EN-N

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Publications Office

doi:10.2760/096340

ISBN 978-92-79-69283-3