THE COMPARE MODEL

METHODOLOGY PAPER

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Summary

This paper presents the COMPARE model of the Danish Energy Agency. The model is a global carbon market model for analyzing international climate change agreements focusing on the trade of emissions, the potential to reduce emissions, the costs of abatement and the adequacy of mitigation targets towards meeting the Copenhagen Accord goal of keeping pre-industrial temperature increase below 2 degree Celsius. The model is based on marginal abatement cost curves from several models providing the holistic picture needed to analyze climate change agreements in the complexity of several gases, sectors and regions. COMPARE allows for a detailed design of carbon trading markets and minimizes abatement costs by assuming cost-effectiveness, i.e. equalizing marginal abatement costs across countries and sectors, meaning that reductions happen where they are cheapest to realize. This paper further presents the key features of COMPARE, the data input into the model and limitations and considerations.

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1 - Introduction

COMPARE is the Danish Energy Agency's (DEA) global carbon market model for analyzing the effect of climate change agreements on global greenhouse gas emissions and global costs of abatement at sector, country and regional level. The model utilizes the principle of cost-effectiveness to minimize abatement costs by reducing emissions where abatement options are cheapest. Marginal abatement cost curves are implemented from several models: the POLES energy-systems model, IIASA's forestry models and PBL's model estimates of non-carbon emissions. Combining these curves provides COMPARE with a transparent and holistic picture of climate change needed when analyzing global climate change agreements.

The Danish Energy Agency uses the model in a variety of analyses work but focus is especially on analyses of individual/aggregate ambition of countries' Intended Nationally Determined Contributions (INDCs). Countries are currently in the phase of submitting their INDCs to the United Nations Framework Convention on Climate Change (UNFCCC) to be used at the Conference of Parties (COP) negotiations. Furthermore, the model participates in external working groups of the EU Commission's climate department: Directorate-General for Climate Action (DG CLIMA) and in cooperation with the UK's Department of Energy and Climate Change (DECC). In the fall of 2015 the model will be used to provide analytical input for the upcoming UNEP emissions gap report. Finally, the DEA utilize the model internally for global- and EU-focused analyses and for analyses on specific countries in the DEA's country-collaboration program, between Denmark and e.g. Mexico.

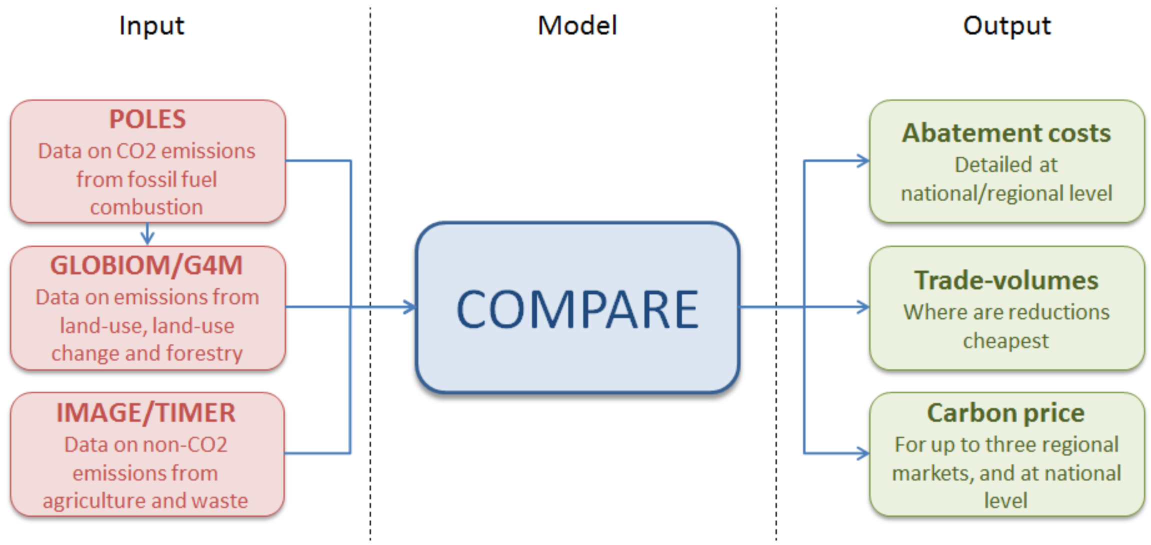
In the next sections we will provide an overview of the model (chapter 2) and explain the key features that COMPARE offers (chapter 3). We will then move into the methodology of the model (chapter 4) and explain the use of marginal abatement cost curves (chapter 5). Data input are discussed (chapter 6) and finally limitations and considerations of the model are presented (chapter 7).

2 - Overview of COMPARE

The COMPARE model was created in the run up to the UNFCCC COP in Copenhagen in 2009 to support the negotiation process. Since then the model has undergone a series of updates: one in 2011, and recently a major update of both functionality and user interface in the fall of 2014. The energy consultancy firm Enerdata has been key in developing the model – both the main input data and the mechanisms and coding of the model. COMPARE is Excel based and simple to operate.

COMPARE is a simple tool for analyzing regimes of international climate change agreements. The model offers quantified estimates of trade volumes and costs of abatement for key emitting countries and regions of the world. Where some models only look at CO_2-individually COMPARE unites CO_2, non-CO_2 and LULUCF data sources into one model and thus provides a holistic picture of all GHG emissions. The model looks at global greenhouse gas emissions and the options available for abatement from 2015 up to 2050, in 5-year intervals. COMPARE receives input from several models, as shown in figure 1. Further detail on input data follows in the section titled "Data Input".

Figure 1: Overview of the COMPARE model - inputs and outputs.



3 - Key features of COMPARE

The core in COMPARE is setting up carbon trading markets. Emissions are allocated to each market, targets are determined and from this COMPARE calculates how reductions are delivered cost-effectively. It does this by equating marginal abatement costs globally over sectors and countries minimizing overall costs to society. The model allows for a detailed design of carbon trading markets. Emissions from each sector within each individual country can be allocated to an international or regional carbon market, to a domestic carbon market or to no market. In total up to three international markets can be designed, and emissions trading between them can be allowed at different levels. Emissions from countries can also be allocated towards international carbon credits, meaning that a country's reduction efforts will be sold at the international carbon credits market to countries meeting their mitigation target using international market mechanisms. Emission allowances within each market can be grandfathered, i.e. distributed for free, or auctioned to create revenue. This can be set sector by sector. If there is a surplus of emissions from a previous commitment period, this surplus can be included as banked emission allowances for a country or sector, effectively decreasing the level of reduction efforts needed to meet a specific mitigation target within the given period.

A price floor or ceiling can be set within each market to establish a minimum and/or maximum carbon price in the specific market. This can be done to keep costs for participating firms down while maintaining environmental integrity.

Mitigation targets can be set at sector or country level using a range of base years (1990, 2000, 2005 and 2010) or using a reduction under baseline emissions (BAU). Furthermore, intensity targets such as reductions in emissions per capita or emissions per GDP can be utilized. Abatement potential can be limited or increased as new information arises, e.g. because of corruption indices, transaction costs, technology improvements etc.

COMPARE can include international financing options, such as the Green Climate Fund (GCF), voluntary funds or transfers, etc. Donor countries and their individual donor amounts can be specified, e.g. as percentage of GDP. For receiving countries it can be specified weather the funds/financing goes towards mitigation action or adaptation action (or what percentage-level that goes to each).

Solving the model yields detailed information on trade-volumes between markets, countries and sectors, together with the flow of funds. The reductions of each individual sector are presented together with marginal abatement costs and cumulative abatement costs from 2015 and up to the mitigation target year. Thus, COMPARE answers how costs of abatement are divided between countries/regions and where emissions are being reduced. This way it becomes evident which countries that are net sellers of carbon credits and which countries that are net buyers. The effect of trade is parameterized as reduction costs when using carbon trading is compared to reduction costs with no trade (only utilizing domestic reduction potential). Marginal abatement costs for each sector, and the carbon price of each market, are also obtained.

4 - Methodology of the model

The COMPARE model is based on the principle of cost effectiveness, i.e. equalizing marginal cost of abatement across sectors and countries participating in a market to minimize overall costs to society. Cost-effectiveness is the analysis of the least cost means of meeting some target of environmental outcome, without questioning this target (Perman et al., 2003). This methodology utilizes the difference in abatement options, and thus abatement costs, between different countries and sectors together with a reduction objective to determine a market price. This reveals information on trade with emission permits, since parties that struggle to meet domestic reduction goals will seek cheaper reduction options from parties who can easily meet their reduction goals and who are willing to increase abatement to earn revenue from selling carbon permits in the market. Thus, COMPARE distributes emission reductions over sources and sectors following the least-cost approach. This also means using flexible mechanisms of the Kyoto Protocol, such as International Emissions Trading (IET), Clean Development Mechanisms (CDMs) and Joint Implementation (JI).

COMPARE does not take account of climate functions such as temperature increase or radiative forcing, which the FAIR model of the PBL does (den Elzen & Lucas, 2005)[1]. By not doing so, COMPARE cannot implement optimal policy in terms of cost-efficiency[2] because it does not take account of marginal benefits of climate change abatement. It is however not essential that COMPARE considers the marginal benefits of climate change abatement. Every

[1] Otherwise, COMPARE and the FAIR model are quite comparable in terms of the underlying methodology as they are both based on cost-effectiveness and marginal abatement cost curves.
[2] Efficiency refers to the question of whether the benefits of the policy outweigh the costs associated with the policy. A policy is efficient if it maximizes global aggregated net benefits (Aldy et al. 2003).

five years IPCC releases global climate change assessment reports that clearly indicate that anthropogenic greenhouse gas emissions are 95-100 pct. responsible for the increase in the average surface temperature since the industrial age (IPCC, 2013). This suggests limiting the release of greenhouse gas emissions, but does not answer at what rate. Models that equate marginal abatement costs and marginal abatement benefits can answer this question from a cost-optimal policy perspective but since marginal abatement benefits are extremely uncertain it is difficult to present a consistent mitigation pathway by looking at results from this type of models (Clarke et al, 2014). Optimal policy might be preferred from a theoretical point of view, but the reality is that reduction objectives are determined politically, both nationally and in the UNFCCC. Many different interests are at play when determining reduction objectives, meaning that optimal policy outcomes are unlikely to occur. At the COP in Copenhagen in 2009 parties to the UNFCCC recognized "the scientific view that the increase in global temperature should be below 2 degrees Celsius" (UNFCCC, 2009). This suggests that it is not a matter of finding the optimal policy level of abatement, but about distributing the reduction efforts needed for a 2 degree world. The COMPARE model takes mitigation targets as input and focuses on minimizing abatement costs from the given targets. This ensures that the results from COMPARE are cost-effective – even though the initial allocation between countries might not be.

5 - Marginal abatement cost curves

COMPARE is based on marginal abatement cost curves (MACCs). A number of models are used to create the MACCs going into COMPARE to obtain a holistic picture of global greenhouse gas emissions across a variety of sources and sectors. Figure 1 presents an overview of these models. The POLES energy systems model, from the energy consultancy firm Enerdata, creates MACCs for the abatement potential of fuel combustion CO_2 emissions, especially the energy, industry and transport sector. COMPARE relies on several model estimates for the potential to reduce non-carbon emissions (such as methane and nitrous oxide), compiled by the PBL Netherlands Environmental Assessment Agency[3]. Lastly, the International Institute for Applied Systems Analysis (IIASA)'s GLOBIOM and G4M forestry-models are used, with input from POLES for demand for wood products and biofuels, to create MACCs for the reduction potential in the land-use, land-use change and forestry (LULUCF) sectors. Combining all these MACCs have the advantage of providing a transparent and holistic picture of abatement options available to a country, including the full flexibility of reducing different greenhouse gases by the use of global warming potentials (GWP).

A MACC is defined as "...a graph that indicates the cost, usually in $ or another currency per ton of CO_2, associated with the last unit (the marginal cost) of emissions abatement for varying amounts of emission reduction" (Kesicki & Strachan, 2011 p. 1195). MACCs can differ in how they are derived, depending on the model setup used to create them. The MACCs in COMPARE are derived by applying a linear carbon price trajectory globally and equally in all sectors. A carbon price is the equivalent of introducing a tax on fossil fuel emissions, which will result in reduction efforts. At different carbon price levels the reduction effort is recorded, thus creating the MACC. The shortcomings of using MACCs will be explored in some detail in the "Limitations and considerations of COMPARE" chapter.

The marginal abatement cost estimates in COMPARE are expressed as the additional costs of imposing a carbon price on emissions of greenhouse gases compared to a business as usual

[3] Mainly using the TIMER energy systems model and the IMAGE integrated environmental model (Lucas et al., 2007; Stehfest et al., 2014), together with work done by the US-EPA and ECOFYS.

scenario with no carbon price introduced. COMPARE provides cumulative abatement costs over a five year period, starting from 2015 and summed to the analyzed target year, e.g. 2020, 2035 or 2050.

6 - Data input

COMPARE includes data on historical emissions for the years 1990, 2000, 2005 and 2010, and business as usual emissions and MACCs starting from 2015 going to 2050, in five-year steps. The model covers all the Kyoto Protocol gases: Carbon dioxide (CO_2), Nitrous oxide (N_2O), Methane (CH_4), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). Nitrogen trifluoride (NF_3) and black carbon emissions are not covered. Global warming potentials from IPCC's fourth Assessment (AR4) are used for converting non-carbon emissions to carbon equivalents. COMPARE covers global emissions and potentials of greenhouse gases divided into 17 countries plus the 28 member states of the EU plus 12 regional aggregates, giving a total of 57 countries/regions. Each country/region is further split into 17 sectors that can be aggregated to 7 categories of emissions sources (Power, Industry, Tertiary, Transport, Waste, LULUCF and International Bunker emissions). For a complete list of sources and for historical and baseline emissions and MACC data, please see table 1 in annex. This table also presents the breakdown of categories into sectors and the year of most recent data update. Input from the POLES model was updated in the summer of 2014, input from IIASA in the fall of 2014, and input data from PBL was implemented in the summer of 2015. A short description of each of the models used to create the MACCs for COMPARE can be found in table 2 in annex. For a list of countries/regions in COMPARE please see table 3 in annex.

LULUCF emissions data and reduction potentials are subject to great uncertainties, especially the projection of the potential of forest management. As a result the forest management reduction option is by default disabled in COMPARE. Emissions from peat fires are also not represented in COMPARE. Further, COMPARE includes emissions and reduction potentials for the international bunker sector, but only international aviation can be regulated in the model. This is due to the fact that Enerdata does not regulate the international maritime sector in POLES, assuming that this sector is not subject to the same kind of regulations as domestic activities. As a result emissions from this sector can actually be expected to increase when a carbon price is implemented and other sectors decrease their use of fossil fuels. This is because when other sectors decrease their consumption of fossil fuels it will decrease the price of fossil fuels and thus it becomes cheaper for the maritime sector to use more fuel.

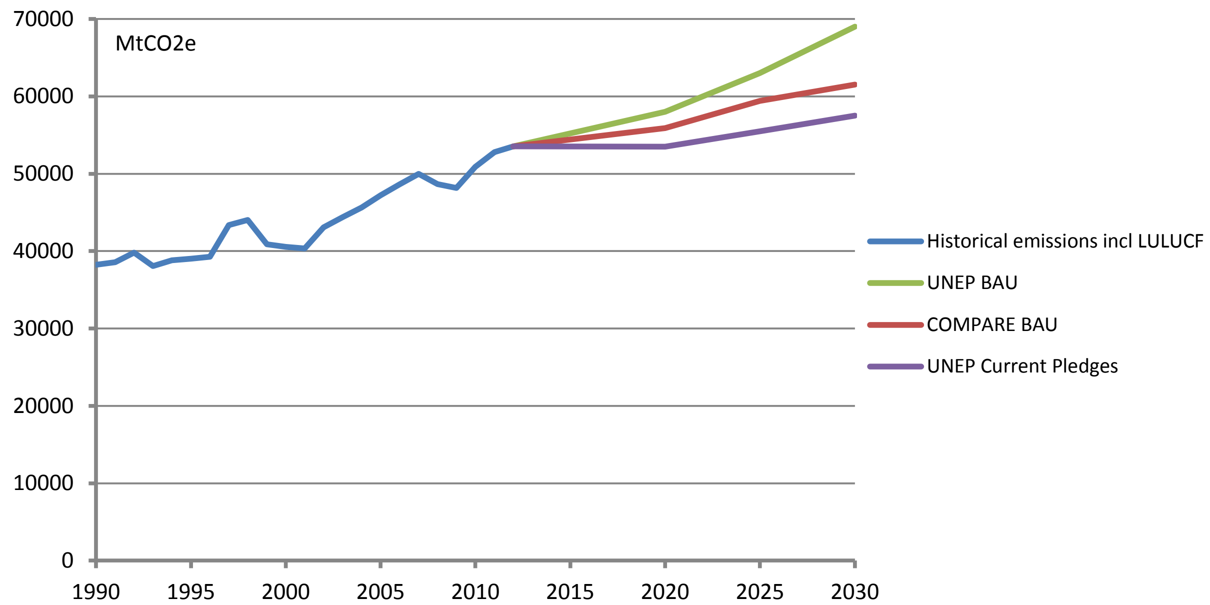
Gross Domestic Product (GDP) growth rates are derived from several sources:
- For the period 1990 to 2012: World Bank, historical GDP values.
- For the period 2013 to 2018: International Monetary Fund (IMF), World Economic Outlook, April 2013.
- For the period 2019 to 2050: Centre for Prospective Studies and International Information, June 2013.

Population growth rates are obtained from UNDP's medium fertility scenario, World Population Prospects, 2012 revision).

In COMPARE the baseline scenario is a so-called business as usual scenario. This means that emissions have been projected using a current policies implemented approach. In POLES the energy related emissions have been calibrated to those of the International Energy Agency's (IEA) World Energy Outlook (WEO) 2013 Current Policy scenario. The difference between

the POLES baseline scenario and the WEO2013 Current Policy scenario is that a zero carbon price is assumed in POLES, meaning that the baseline scenario in COMPARE can be considered a no cost scenario, even though reductions are happening, e.g. in the EU. Because of this COMPARE can underestimate the 'real' cost of abatement efforts, since it does not put a price on measures already present in the baseline[4]. Furthermore, the COMPARE baseline is net of reduction potential available at negative carbon prices[5].
The COMPARE baseline scenario, or BAU, is presented in figure 2 below. The figure compares the COMPARE BAU to that of the United Nations Environmental Program's Emissions Gap report 2014. The COMPARE BAU lies in between the UNEP BAU and the UNEP Current Pledges scenario. Since some pledges are included in the COMPARE BAU (e.g. some Copenhagen pledges, see table 4 of the appendix for more detail) this result does seem valid.

Figure 2: The COMPARE business as usual (BAU) emissions up to 2030, compared to UNEP Gap 2014 BAU and Current Pledges scenarios median values.



Note: For historical emissions of greenhouse gases we have used the EDGAR database, and the UNEP BAU and Current Pledges scenarios are from the UNEP Emissions Gap report 2014.

7 - Limitations and considerations of COMPARE

Using marginal abatement cost curves have the advantage of creating a transparent and holistic picture of global greenhouse gas emissions and reductions available. However, it is also a simplistic method that limits certain aspects of the situation. These include, but are not limited to, the following: COMPARE limits analyses to only carbon pricing, provides no information on technologies used for abatement efforts, inhibits scenario/path dependency, no flexibility for early/late action and provides only low detail level at country level.

The method for creating MACCs using carbon pricing limits the use of mitigation measures to just one economic instrument, when in reality a variety of instruments for mitigation exists such as subsidies, bans, standards (BAT), etc. These options could just as well have been chosen to mitigate climate change. COMPARE cannot explore these options.

[4] If abatement costs were calculated relative to a BAU with NO policies we would get higher costs.
[5] This means that COMPARE BAU emissions differs somewhat from the input sources used for creating MACCs for COMPARE, since these are not net of reduction potential at negative carbon prices.

Another implication of using MACCs is the limit on flexibility in meeting mitigation targets. A linear carbon price trajectory has been used for creating MACCs. This means that a linearly increasing carbon price from implementation in 2015, to the target year, e.g. 2030 is assumed and that ambition is increasing somewhat stable over time. But this might not hold true in many cases. Other trajectories exist such as early or late action, meaning either higher carbon prices in early periods or in later periods. These cases are not captured in COMPARE.

Using linear carbon pricing for creating MACCs can lead to another issue because carbon prices are applied globally in each sector at equal level. This can create a bias in COMPARE if a specific market configuration gives rise to large differences in carbon prices between countries/sectors. Since MACCs are created using equal carbon pricing and this specific situation inhibits very uneven carbon pricing the resulting levels of abatement efforts and costs might have looked different had the MACC resembled the specific situation.

It is important to remember that a MACC is scenario/path dependent (Kesicki & Strachan, 2011). This means that a MACC is a snapshot of one point in time and depends tremendously on the pathway up until that point in time. Had the pathway been different, the MACC would have been different as well.

A MACC simply provides a cost estimate and does not provide any information on which technologies that are utilized to obtain the necessary reduction efforts. This is a serious limitation of MACCs that can possibly hide somewhat controversial information. Models used to create MACCs for COMPARE rely on technologies such as Carbon Capture and Storage (CCS) that is used by coal, gas and biomass power plants to meet very high reduction efforts. This technology is not yet mature and inhibits a range of considerations. Nevertheless the MACCs in COMPARE still assume that this technology can be utilized at full potential from around 2030. Another example is that of nuclear power, which is not limited in COMPARE even though politically it might be done due to safety concerns. Furthermore, the models assume full substitutability between technologies, which can also be disputed.

The POLES model used for creating MACCs for energy related reductions calculate cumulative abatement costs in a way that can lead to overestimation. The model inhibits a range of lagged functions, e.g. the demand for energy which depends on a variation of recent fuel prices that are lagged from one to several years. This lag means that the model can overestimate cumulative abatement costs, since reaction to a carbon price is lagged.

It is important to recognize the limitations of COMPARE and to be aware of which questions the model can answer and at what level of detail. COMPARE provides the global picture needed and otherwise missing from the climate change negotiations. It is best suited at answering, at global and regional level, what amount of reduction effort is needed to combat climate change, and to provide the estimated cost of doing so.

8 - References

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9 - Annex

Table 1: Complete list of sources for COMPARE data input. Data input includes emissions data, both historical and baseline emissions, and marginal abatement cost curves.

Category	Sector	Gas	Source	Updated
Power	Power	CO_2	POLES	2014
Power	Power	SF_6	PBL	2015
Industry	Chemicals	CO_2	POLES	2014
Industry	Chemicals feedstock	CO_2	POLES	2014
Industry	Chemicals production	N_2O	PBL	2015
Industry	Manufacturing – Non-energy	CO_2	POLES	2014
Industry	Manufacturing – Other	CO_2	POLES	2014
Industry	Manufacturing	HFC	PBL	2015
Industry	Manufacturing – Aluminum	PFC	PBL	2015
Industry	Manufacturing – Other	PFC	PBL	2015
Industry	Manufacturing	SF_6	PBL	2015
Industry	Upstream & refining – Other	CO_2	POLES	2014
Industry	Upstream & refining – Coal	CH_4	PBL	2015
Industry	Upstream & refining – Gas	CH_4	PBL	2015
Industry	Upstream & refining – Oil	CH_4	PBL	2015
Industry	Upstream & refining – Coal transport	CH_4	PBL	2015
Industry	Upstream & refining – Gas transport	CH_4	POLES	2014
Industry	Steel	CO_2	POLES	2014
Industry	Mineral products	CO_2	POLES	2014
Tertiary	Residential	CO_2	POLES	2014
Tertiary	Services	CO_2	POLES	2014
Tertiary	Agriculture	CO_2	POLES	2014
Tertiary	Agriculture	CH_4	PBL	2015
Tertiary	Agriculture	N_2O	PBL	2015
Transport	Road	CO_2	POLES	2014
Transport	Road	N_2O	PBL	2015
Transport	Rail	CO_2	POLES	2014
Transport	Other transport	CO_2	POLES	2014
Transport	Domestic Air	CO_2	POLES	2014
International Bunkers	International Air	CO_2	POLES	2014
International Bunkers	International Maritime	CO_2	POLES	2014
Waste	Waste – sewage	N_2O	PBL	2015
Waste	Waste – landfills + sewage	CH_4	PBL	2015
LULUCF	Afforestation	CO_2	IIASA	2014
LULUCF	Deforestation	CO_2	IIASA	2014
LULUCF	Forest Management	CO_2	IIASA	2014

Table 2: Short description of the models used to create marginal abatement cost curves for COMPARE

Model	Description
POLES	- The POLES model is a world energy-economy partial equilibrium recursive simulation model of the energy sector, with complete modeling from upstream production through to final demand. The model relies heavily on endogenous calculation of international energy prices and technology costs and covers the global energy system. POLES is developed and used by JRC IPTS, Université de Grenoble CNRS, and Enerdata (Kitous et al., 2010; Enerdata, 2014).
IMAGE	- The IMAGE model is a dynamic integrated assessment modelling framework for global change, developed by the Dutch Environmental Assessment Agency, PBL. The core of the IMAGE model comprises most parts of the Human system and the Earth system, including: the energy system (the TIMER model), land-use, and the plant growth, carbon and water cycle model. A number of sub-models are integrated via soft-links, such as the FAIR climate policy model and the biodiversity model, GLOBIO (Stehfest et al., 2014).
TIMER	- The TIMER model is a simulation model of the global energy system at a somewhat aggregated level. It is mostly bottom-up based, with specific information on investment behavior and technology used in the energy sector. It is possible to use the model as a stand-alone, but it is mostly used soft-linked to the IMAGE model (Van Vuuren et al., 2014).
GLOBIOM	- The GLOBIOM model is a global, recursive dynamic, and partial equilibrium model that integrates agriculture, biofuels, forest sectors and geophysical land data. It assumes that there is competition for land-uses from all these sectors and finds a general equilibrium maximizing consumer and producer surplus. The model is closely linked to the G4M model (Havlík et al., 2014).
G4M	- The G4M global forest model simulates land use change by comparing the level of income that can be obtained by alternative land-use activities, e.g. planting grains for food or planting forests, and sustainable forest management aimed at satisfying wood demand. The model is linked to the GLOBIOM model to create MACCs for the world regions of COMPARE (Gusti, 2010).

Table 3: Complete list of countries and country aggregated in COMPARE.

Countries		
Austria	Latvia	China
Belgium	Lithuania	India
Bulgaria	Luxembourg	Indonesia
Croatia	Malta	Japan
Cyprus	Netherlands	Mexico
Denmark	Poland	Egypt
Estonia	Portugal	Norway
Spain	Czech Republic	Iceland
Finland	Germany	Switzerland
France	Romania	Russia
United Kingdom	Slovakia	South Africa
Greece	Slovenia	South Korea
Hungary	Sweden	Turkey
Ireland	Brazil	Ukraine
Italy	Canada	United States

Country aggregate	Countries included
Middle East	Israel, Jordan, Lebanon, Syria
Gulf countries	United Arab Emirates, Bahrain, Iran, Iraq, Kuwait, Oman, Qatar, Saudi Arabia, Yemen.
Algeria & Libya	Algeria and Libya
Tunisia & Morocco	Tunisia and Morocco
Australia & NZ	Australia and New Zealand
Central America	Bahamas, Belize, Bermuda, Barbados, Costa Rica, Cuba, Dominica, Dominican Rep., Grenada, Guatemala, Honduras, Haiti, Netherlands Antilles & Aruba, Jamaica, St. Lucia, Nicaragua, Panama, El Salvador, Trinidad, St Vincent & the Grenadines
Central Europe	Bosnia-Herzegovina, Macedonia, Serbia & Montenegro, Albania
CIS (-RUS)	Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyz Rep., Moldova, Tajikistan, Turkmenistan, Uzbekistan.
South America (-BRA)	Argentina, Bolivia, Chile, Colombia, Ecuador, Suriname, Guyana, Peru, Paraguay, Uruguay, Venezuela.
South Asia (-IND, -IDN)	Pakistan, Afghanistan, Bangladesh, Bhutan, Sri Lanka, Maldives, Nepal.
South-East Asia	Brunei, Myanmar, Cambodia, Lao, Macau, Malaysia, Mongolia, Philippines, North Korea, Singapore, Thailand, Taiwan, Vietnam
Sub-Saharan Africa	Angola, Burundi, Benin, Burkina Faso, Botswana, Central African Rep, Cameroon, Congo, Comoros, Cape Verde, Djibouti, Eritrea, Ethiopia, Gabon, Ghana, Guinea, Gambia, Guinea-Bissau, Guinea Equatorial, Ivory Coast, Kenya, Liberia, Lesotho, Madagascar, Mali, Mozambique, Mauritania, Mauritius, Malawi, Namibia, Niger, Nigeria, Rwanda, Sudan, Senegal, Sierra Leone, Somalia, Sao Tome & Principe, Swaziland, Seychelles, Chad, Togo, Tanzania, Uganda, Zimbabwe, Zambia, Zaire.

Table 4: Incomplete list of policies assumed in the World Energy Outlook Current Policy Scenario 2013.

Country/region	Policies assumed implemented
United States	- State-level renewable portfolio standards (RPS) that include the option of using energy efficiency as a means of compliance. - Regional Greenhouse Gas Initiative (RGGI): mandatory cap-and-trade scheme covering fossil fuel power plants in nine northeast states including recycling of revenues for energy efficiency and renewable energy investments. - State-wide cap-and-trade scheme in California with binding commitments.
European Union	- EU-level target to reduce GHG emissions by 20% in 2020, relative to 1990. - EU Emissions Trading System. - Renewables to reach a share of 20% in energy demand in 2020.
Australia and New Zealand	- Australia: Clean Energy Future Package – carbon prices through taxes/emissions trading scheme as of mid-2015. - New Zealand: emissions trading scheme from 2010.
Korea	- Cap-and-trade scheme from 2015 (CO_2 emissions reductions of 4% by 2020 compared with 2005).
Non-OECD	- Fossil-fuel subsidies are phased out in countries that already have policies in place to do so.
Russia	- Gradual real increases in residential gas and electricity prices (1% per year) and in gas prices in industry (1.5% per year). - Implementation of 2009 energy efficiency legislation.
China	- Implementation of measures in the 12th Five-Year Plan, including 17% cut in CO_2 intensity by 2015 and 16% reduction in energy intensity by 2015 compared with 2010.
India	- Trading of renewable energy certificates. - National solar mission and national mission on enhanced energy efficiency. - 11th Five-Year Plan (2007-2012).
Brazil	- Implementation of National Energy Efficiency Plan.