Climate change modelling information

Quarterly report – Q2 2020 report

27 April 2020

Submitted to:

European Commission

DG Climate Action

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A report submitted by ICF Consulting Limited

Date: 27 April 2020

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Contents

1   High-level executive summary

This report under the "Climate change modelling information" series presents relevant developments reported by key international climate modelling institutions. This issue sets a particular emphasis on mid-century strategies, nationally determined contributions (NDCs), and the representation of socio-economic mechanisms.

The first section of the report features a study modelling the implementation of **mid-century strategies**. Researchers at IIASA have developed a new IAM scenario logic that improves the representation of Paris Agreement temperature targets and climate response uncertainties to make explicit the intergeneration bias of current IAM models, in most of which the burden is carried by future generations. Another study examines decarbonisation pathways and energy investment needs for developing Asia, and concludes that a radical transformation of the energy system is needed to meet the "well below" 2°C target.

Various developments linked to the implementation of the **Nationally Determined Contributions (NDCs)** are reported on in the second section. Two recent studies from PBL Netherlands provide a 2019 update to greenhouse gas mitigation scenarios for major emitting countries and a meta-analysis on international shipping and aviation emissions projections from Integrated Assessment Models. The 2019 Global Energy and Climate Outlook from the Joint Research Centre examines the role of electrification in the low-carbon transition. An article in the *Journal of Transport and Health* evaluates the co-benefits of air quality and health improvement in China. And lastly, researchers in Australia are developing a new tool to help policymakers build net-zero emissions scenarios for Australian industries at the national and state/territory levels.

In the last section, the report features research linked to the better **representation of the socio-economic mechanisms** of climate policy. A new metamodel of the costs of climate policy from Utrecht University and PBL Netherlands disaggregates the uncertainties linked to physical and socio-economic factors; it finds that more ambitious climate targets are associated with higher uncertainty in socio-economic factors such as economic growth, population growth and changes in human behaviour. Research from the University of Waterloo in Canada shows the utility of the cross-impact balances (CIB) technique to construct global socio-technical scenarios for climate change research. A paper from the Inter-American Development Bank explores the labour impact of four scenarios of electricity generation in Chile, including three coal power phase-down scenarios.

The European Commission DG CLIMA **will shortly publish a call** for a project entitled **Modelling of greenhouse-gas emissions relevant to the Paris Agreement (informing successive NDCs in light of the Global Stocktake).** A Prior Information Notice has been published at the address below. A more detailed Contract Notice will follow. Search for reference number 140784.

https://webgate.ec.europa.eu/europeaid/online-services/index.cfm?ADSSChck=1586886673376&do=publi.welcome

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2 Introduction

This report is the second quarterly report of 2020 under the series "Climate change modelling information" financed by the European Commission. The objective of this series is to inform the European Commission and the wider climate change and energy modelling community about recent and relevant modelling developments. The data presented in this report were collected through an open survey sent to more than 200 modelling teams worldwide and open from 10 to 24 March 2020.

The survey asked modellers to report relevant developments with a focus on the implementation of Nationally Determined Contributions (NDCs), mid-century strategies and the representation of socio-economic mechanisms in climate models. Although the objective of this report is to present an extensive list of recent developments, it cannot be considered as exhaustive. For this quarterly report, responses came from 6 countries (see Figure 2.1), 9 different organisations and covered 10 different modelling developments and projects.

Additional research was also undertaken to complement the survey results.

Figure 2.1   Geographical coverage of climate change modelling developments reported through the online survey (n = 9)
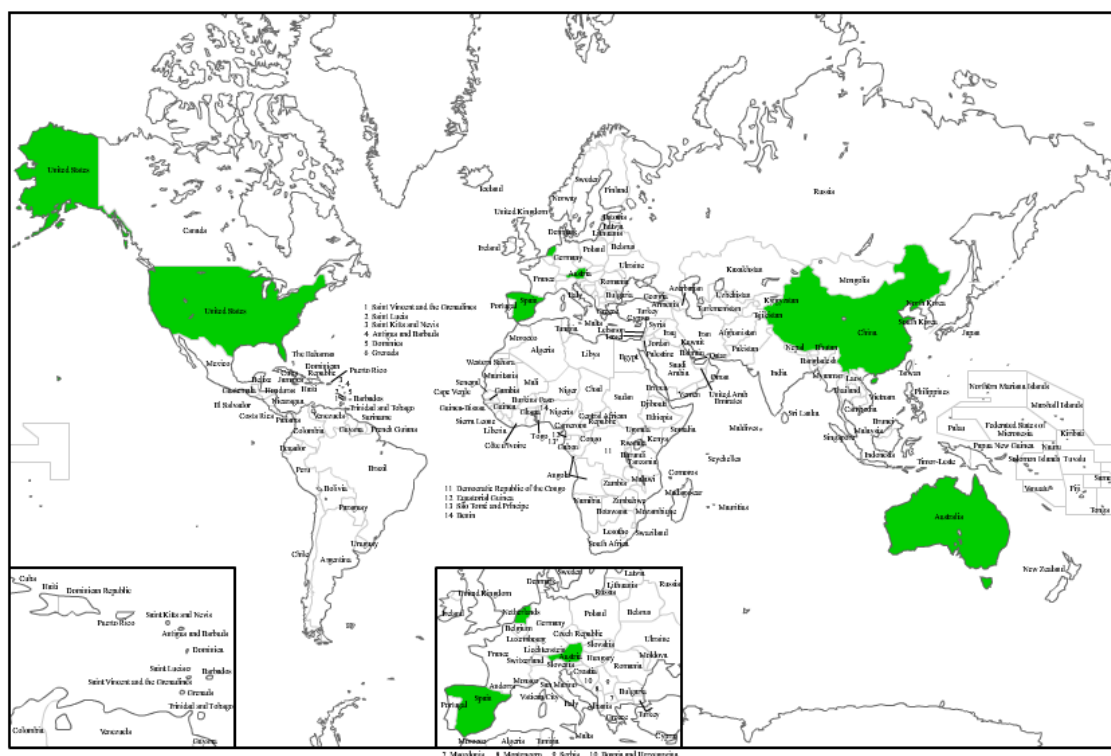
Source: ICF, 2020. Climate change modelling information Q2 2020 survey.

The modelling developments discussed in this report are summarised below and further described in the coming chapters.

Modelling developments linked to the implementation of mid-century strategies:

- New IAM scenario logic that improves the representation of Paris Agreement temperature targets and climate response uncertainties (Austria)

- Decarbonisation pathways and energy investment needs for developing Asia (Austria)

Modelling developments linked to nationally determined contributions (NDCs):

■ [2019 update to greenhouse gas mitigation scenarios for major emitting countries](#) (Netherlands)

■ [Meta-analysis on international shipping and aviation emissions projections from Integrated Assessment Models](#) (Netherlands)

■ [2019 Global Energy and Climate Outlook](#) (Spain)

■ [Co-benefits of air quality and health improvement](#) (China)

■ [Net-zero emissions scenarios for Australian industries at the national and state/territory levels](#) (Australia)

Modelling developments covering the representation of socio-economic mechanisms:

■ [New metamodel for estimating costs of climate policy](#) (Netherlands)

■ [Cross-impact balances (CIB) technique for constructing global socio-technical scenarios for climate change research](#) (Canada)

■ [Labour impacts of decarbonisation in Chile](#) (USA)

3 Modelling developments linked to the implementation of mid-century strategies

■ Researchers at the [International Institute for Applied Systems Analysis](#) (IIASA) have developed a new IAM scenario logic that improves the representation of Paris Agreement temperature targets and climate response uncertainties. To understand how global warming can be kept below 2°C, climate policy uses scenarios that describe how society could reduce its GHG emissions over the long term (2100). However, focusing on reaching specific climate goals in 2100 may encourage risky pathways that delay action, reach higher-than-acceptable mid-century warming, and rely on net removal of carbon dioxide thereafter to compensate for their initial shortfall in reductions of emissions. These pathways contain an implicit intergenerational bias – the burden is carried by future generations, and most likely by vulnerable populations. The authors propose a scenario framework that focuses on capping global warming at a specific maximum level with either temperature stabilization or reversal thereafter. The ambition of climate action until carbon neutrality determines peak warming. The research article published in *Nature* is available [here](#), and a [blog post](#) in the [Carbon Brief](#) describes the policy importance of the novel modelling development.

■ A recent [article](#) in the journal [Climate Policy](#) examines potential decarbonisation pathways and energy investment needs for developing Asia in line with the "well below" 2°C target. The authors employ the global integrated assessment model MESSAGEix-GLOBIOM to model mid-century decarbonisation strategies for countries in Asia to 2050. The key finding from the study is that a radical transformation of the energy system is required to meet the emissions target and that low-carbon investments may need to double or triple. The need for such investment could be met through green finance and the mobilisation of private capital. The low-carbon investment would reduce the investment needs for achieving the sustainable development goal (SDG) target for air quality, and slightly increase the investment needs for achieving the clean water and food security targets.

4 Modelling developments linked to Nationally Determined Contributions (NDCs)

■ The NewClimate Institute, PBL Netherlands Environmental Assessment Agency and the International Institute for Applied Systems Analysis (IIASA) have issued a 2019 update to greenhouse gas (GHG) mitigation scenarios for major emitting countries. The report provides an overview of projected GHG emissions in 25 major emitting countries/regions up to 2030 (including the EU), taking into account the emission trajectories based on current policies and the implementation of nationally determined contributions (NDCs). The report concludes that 12 out of the 25 countries and regions are not on track to achieve their NDC targets. The report updates the 2018 report, and for the first time presents additional key indicators in addition to GHG emissions. Some of these new indicators include GHG emissions per GDP, share of renewables in total primary energy supply (TRES), share of renewables in total electricity generation, TRES per capita, and TRES per GDP.

■ Another team of researchers at PBL Netherlands Environmental Assessment Agency has published a new meta-analysis on international shipping and aviation emissions projections from Integrated Assessment Models (IAMs). Emissions from international transport are underrepresented in these models. This new report is based on a survey and interviews with IAM teams, and a comparative analysis of published emissions projects for the transport sector from IAMs and non-IAM models. The key finding is that the reason for underrepresentation of the international shipping and aviation sectors is the lack of easily available data. The report makes a few recommendations for improving the representation of these sectors in IAMs: distinguishing between aviation and shipping emissions; distinguishing between national and international emissions for the two sectors; incorporating fuels, efficiency standards, and energy or transport demand factors improving the use of soft-linked sectoral models.

■ The Joint Research Centre (JRC) of the European Commission has published the 2019 Global Energy and Climate Outlook (GECO). This edition of the outlook focuses on the role of electrification for the low-carbon transition. It provides in-depth analysis of electrification including a sensitivity analysis to capture multiple pathways to 2°C, which are differentiated in the contribution of low carbon electricity. The report covers large sectors (industry, transport, buildings and power generation), and has a regional focus on the EU and China and a sectoral focus on road transport electrification. In the CGE model, the car manufacturing sector was split into conventional vehicles and electric vehicles to analyse the effects of EV uptake on employment. The key finding is that well below 2°C can be achieved by a simultaneous transformation of a number of elements of the energy system (decarbonising power generation, shifting energy demand towards electricity and low-carbon synthetic fuels, increasing energy efficiency), and that meeting the target is possible at relatively low cost for the overall economy. The 2019 and previous editions of the GECO are available here.

■ Researchers at Peking University have published an article in the *Journal of Transport and Health* evaluating the co-benefits of road transportation in China. The study integrates an energy economy model (IMED/CGE), an air pollutant emission model (GAINS), and a health impact assessment model (IMED/HEL) to analyse the benefits of air quality and health improvement that could be achieved in China under 2°C target and following mitigation policies focusing on road transport. This study better evaluates the costs and benefits of sectoral mitigation strategies and distinguishes between the contribution of mitigation actions and air pollution control actions. The results show that achieving the 2°C

climate target could significantly reduce PM$_{2.5}$ pollution and the health and economic losses in China, in which the road transportation sector would play an important role. The study also finds that various policy choices in the road transport sector (e.g. at national and provincial level) for achieving the 2°C climate target have the potential to contribute to emission reductions in the transportation sector. Some of these policies are improving road transport infrastructure, developing electric vehicle transport via subsidies, and an upgrade of the emissions standards and fuel quality. More importantly, the co-benefits of climate actions could already be very significant compared with that of air-pollution control strategy.

- Researchers at the Crawford School of Public Policy at Australian National University are developing net-zero emissions scenarios for Australian industries at the national and state/territory levels. The model brings together industry-level economic output data and emissions data. The researchers use existing studies of net-zero emissions trajectories in Australia to define the scenarios. The model will support development of national and state/territory 2050 strategies in Australia, and the project team works in close engagement with national and state governments. It is a simple MS Excel-based model (based on the Kaya identity) that can be used by policy advisors, bureaucrats and decision-makers to support formulation of long-term climate strategies. A web-based front-end will be produced at a later date for broader public engagement. The work is in progress.

5 Modelling developments covering the representation of socio-economic mechanisms

- In a recently published article in *Nature Climate Change,* researchers at PBL Netherlands Environmental Assessment Agency and Utrecht University present a single transparent metamodel of climate change action which estimates the costs of reducing GHG emissions, the impact of the emissions on climate change and the socio-economic developments associated with the costs and emissions. The main finding of the study is that the cost of limiting global temperature increase to below 2°C – or even below 1.5°C – would be between 2% and 4% of global aggregate income for the period 2015-2100. However, these estimates come with a large margin of uncertainty – the costs of keeping global temperature increase under 1.5°C could be three times higher or lower than estimated. This uncertainty is largely a product of uncertainty in physical factors (e.g. relationship between GHG and temperature increases) and socio-economic developments (e.g. population growth, economic growth, human behaviour). The uncertainty of achieving the more ambitious temperature targets are mainly socio-economic uncertainties, which shows that climate change costs and impacts should be taken into account in all policy areas, not just climate policy. The findings also show that more research is needed to develop data and models that improve the estimates of socio-economic factors and decrease the margin of uncertainty. The data and model code used in the article are publicly available online.

- Research from the University of Waterloo in Canada reflects on the use of the cross-impact balances (CIB) technique to explore uncertainties in climate change research. CIB uses scenarios rather than relying only on expert predictions, and the article applies the technique in two areas: 1) socio-technical uncertainties not represented in IAMs, and 2) sampling the space of possible futures to model. The key finding is that CIB can reveal system behaviours that are not obvious when social variables (e.g. quality of governance) are not

explicitly modelled in IAMs. Moreover, CIB can algorithmically rank the possible future scenarios to model based on how self-consistent they are. The CIB technique can improve the choice of what possible futures to model. These choices are usually based on expert intuitions and what looks "obvious" – which often leads to analysis of only a sub-set of policy options. The article is available online.

- A new discussion paper from researchers at the Inter-American Development Bank estimates the labour impacts of decarbonisation in Chile. The study explores the labour impact of four scenarios of electricity generation in Chile, including three coal power phase-down scenarios. These scenarios were developed by the government of Chile to inform the debate on the appropriate timing of coal phase out in Chile. The authors find that the four scenarios would result in the creation of between 32 and 40 thousand direct and indirect jobs and between US$1.7 and US$1.8 billion in value added in 2030, compared to present-day situation. These net numbers, however, mask the sectoral and regional distribution of new jobs and value added created. The most significant negative impact would be the gradual disappearance of 4 thousand jobs in coal power plants by 2030 or 2050 depending on the scenario. These impacts are not significant when compared to the size of Chile's labour markets and GDP. Chile's economy routinely creates more than 40 thousand jobs per trimester, and US$1.7 billion is just 0.8% of GDP, while GDP is expected to grow at least 2.5% per year between today and 2030. At the national level, the results suggest that a careful planning and implementation of coal phase-out could be able to mitigate its negative impacts, given that they will be small relative to the size of Chile's economy. Whether the jobs created nationally will match the skills available in the geographical location of current coal power plants is likely to play a key role. A separate forthcoming technical note studies affected communities in more details and will provide lessons learned from the historic management of the labour impacts of policy reforms.