



# Climate change modelling information

Quarterly report – Q1 2020 report

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Quarterly report – Q1 2020 report

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[Jerome Kisielewicz](#)  
4th Floor  
Avenue Marnix 17  
1000 Brussels  
T +32 (0) 2 275 01 00  
F +32 (0) 2 275 01 09  
[jerome.kisielewicz@icf.com](mailto:jerome.kisielewicz@icf.com)  
[www.icf.com](http://www.icf.com)



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# 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 and nationally determined contributions (NDCs).

The first section of the report is dedicated to modelling developments linked to the implementation of **mid-century strategies**. Using an hourly electricity dispatch and capacity investment model, EleMod, researchers in the U.S. investigate the potential role of nuclear power in the decarbonisation of the U.S. electricity sector. They find that, with low electricity generation costs of nuclear, advanced nuclear power can contribute, together with solar and wind, to achieving the 90% CO<sub>2</sub> emission reduction target by reducing the carbon price. A study assessing Japan’s mid-century emission pathways is the first to integrate global and national models to show that additional mitigation action beyond the NDC is necessary to achieve the low-carbon budget scenario after 2030. The Center for International Forestry Research in Germany is developing a nature-based solutions framework to inform the Green Climate Fund’s strategic section.

Various developments linked to the implementation of the **Nationally Determined Contributions (NDCs)** are reported on in the second section. A recent article estimates the macroeconomic impacts on the European Union’s economy of different EU decarbonisation pathways towards a below 2°C climate stabilisation. Researchers at COPPE/UFRJ have developed a new household income disaggregation method for the TEA model and will use it to assess the heterogeneous effects of introducing different schemes of carbon trading on income distribution in Brazil.

In the third section, dedicated to the **links between climate and circular economy**, a study shows how circular economy could create opportunities for the waste-to-energy sector in Norway to develop and expand into new value chains such as secondary raw materials production. Furthermore, an OECD working paper on the macroeconomics of the circular economy transition offers a critical review of the modelling approaches used in the field.

Lastly, a range of other recent climate modelling developments are reported on in the fourth section. The first article presents one of the first studies to quantify the health-co benefits of climate mitigation for the Republic of Korea which faces air quality issues by integrating three different models. Researchers from Australia compare the differences between “transient climate” and “equilibrium climate” modelling techniques and stress the need to take into account these differences in modelling for climate change policies to be effective. NAVIGATE, a new project funded by Horizon 2020 to improve the capability of integrated assessment models to inform the design and evaluation of climate policies, is presented. The report concludes with a summary of methodological advances shared at the 12<sup>th</sup> IAMC meeting in December 2019.

## 2 Introduction

This report is the first 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 7 to 24 January 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 link between climate and circular economy. 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 7 countries (see Figure 2.1), 7 different organisations and covered 8 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 = 7)



Source: ICF, 2020. Climate change modelling information Q1 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:

- [The role of nuclear energy in decarbonisation of the U.S. energy sector](#) (United States)
- [Integration of global and national models to assess Japan's mid-century emission pathways](#) (Greece)
- [A nature-based solutions framework to inform the Green Climate Fund](#) (Germany)
- [New data, feedbacks with sectoral models, and a transport sectoral model available for ENERGYBAL-GEM-2050](#) (Russia)

### Modelling developments linked to nationally determined contributions (NDCs):

- [Macroeconomic impacts on the European Union's economy of different EU decarbonisation pathways towards a below 2°C climate stabilisation](#) (Greece)
- [New multiple household method to disaggregate the single representative agent of a chosen region in Brazil for the TEA model](#) (Brazil)

### **Modelling developments covering the link between climate and circular economy:**

- [The link between climate change, circular economy and carbon capture and storage](#) (Norway)
- [Critical review of modelling approaches used for the circular economy transition](#) (France)

### **Other modelling developments:**

- [The air quality co-benefits of climate mitigation action for human health](#) (Republic of Korea)
- [Comparison of transient climate modelling and equilibrium climate modelling techniques](#) (Australia)
- [NAVIGATE – A New generation of Advanced InteGrated Assessment modelling to support climaTE policy making](#) (Italy)
- [Methodological advances presented at the 12 IAMC meeting](#) (Japan)

## **3 Modelling developments linked to implementation of mid-century strategies**

- Researchers at the [MIT Joint Program on the Science and Policy of Global Change](#) have recently published a [paper](#) investigating the potential role of nuclear power in the decarbonisation of the U.S. electricity sector. In the context of falling costs and improved technology of renewable energy sources, the research team challenges the assumption that even a small increase in carbon price would push the energy mix balance towards renewables and away from natural gas and nuclear. They further develop the hourly electricity dispatch and capacity investment model, [EleMod](#), which goes beyond the levelized costs of each energy source and evaluates how hourly patterns of electricity demand and intermittent supply match up across the United States. The model also includes transmission options to shift electricity from high supply to high demand regions. The paper models scenarios for electricity generation from 2016 to 2050 for all regions of the U.S. and for different energy sources. The results show that to reach deep decarbonisation in the U.S., it will require a substantial carbon price, and that even with modest reductions in the cost of nuclear energy, the needed carbon price can be reduced by 2/3 with the availability of nuclear.
- An [article](#) in the journal of *Climactic Change* assess Japan's mid-century low-emission pathways using national and global integrated assessment models. The researchers link both near-term policies and long-term CO<sub>2</sub> budgets scenarios from seven global and two national IAMs into a common scenario framework, something that has not been done until now. The results show that Japan's NDC policies are consistent with the assessed high-budget scenarios, and therefore the country is on track. However, the results also show that the mitigation effort for the low-budget scenarios would be insufficient without additional mitigation action beyond the NDC after 2030. The article – together with the [study](#) on EU decarbonisation pathways below - is part of a special 2019 issue on "National Low-Carbon Development Pathways."
- At the [Center for International Forestry Research](#) (CIFOR) in Germany, researchers are developing a new Nature-Based Solutions Framework (NBSF) that directly informs the [Green Climate Fund's](#) (GCF) strategic actions. The aim of the project is to demonstrate how nature-based solutions can support the GCF paradigm shift towards low-emission and climate-resilient development. The new

model will project physical climate parameters and land use patterns across four sectors (land use, forests, ecosystems and ecosystem services) to develop sectoral guidance supporting the use of the GCF. The sectoral guidance, informed by a desk-based meta-analysis and consultations across ten themes<sup>1</sup>, will support country-driven processes for national programming, enhance climate ambition, and guide GCF stakeholders to develop transformative project and programme pipelines. This work illustrates current efforts to consider trade-offs and synergies between climate and land use (and other themes<sup>2</sup>) to guide investments to reduce greenhouse gas emissions in developing countries. Concrete actions that need to be taken by the GCF stakeholders to achieve the Strategic Goals for 2025, 2030 and 2050 will be proposed. The results of the project will be available in late 2020.

- The ENERGYBAL-GEM-2050 model has been updated to include new available data, more feedbacks with sectoral models, and a new transport sectoral model. The work has been done by the [Center for Energy Efficiency](#) (CENEf-XXI) in Moscow, and the updated model was used to develop Russia's long-term low carbon strategy to 2050. No new articles have been published yet, but some results using an older model specification to estimate energy efficiency of buildings are [available](#) online in the journal of *Problems of Economic Transition*.

## 4 Modelling developments linked to Nationally Determined Contributions (NDCs)

- Another recent [article](#) in *Climactic Change* estimates the macroeconomic impacts for the European Union's economy of the different EU decarbonisation pathways towards a below 2°C climate stabilisation. The research team uses two soft-linked models: the energy system [PRIMES](#) model and the hybrid general equilibrium [GEM-E3](#) model. The PRIMES model projects energy demand, supply, market prices, and system costs and investment in the EU with Member State level detail up to 2050. GEM-E3 models macroeconomic and sectoral impacts of the interconnections of the environment, the economy, and the energy systems. The model also takes into account the climate action of other major emitters. The results show that the transition to low carbon requires transformations in all production and consumption patterns and the energy system, but also that the transition is possible with the existing technology portfolio. Up to 2030, the energy supply sector leads in emission reductions, and the transport sector takes the lead in 2050. The scenarios show that the transformation process is capital-intensive, and this will have an impact on poverty and inequality. The article is of particular interest to policy makers as the assessed scenarios feature European Commission policies "Clean Energy for all Europeans" linked to the "2030 Climate and Energy Framework" and the EU NDC.
- A new multiple household income method to disaggregate the single representative agent of a chosen region (Brazil) is available for the Total Economy Assessment ([TEA](#)) model. The TEA model is a global recursive dynamic CGE model developed at the [COPPE/UFRJ](#) in Brazil. The regional household is disaggregated by income deciles, according to a micro-dataset

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<sup>1</sup> The ten themes are trends and drivers, NDCs, REDD+, carbon markets, non-carbon benefits, how to assess ecosystem services, climate investment and finance, the role of the private sector, rights, which factors are promoting true paradigm shift.

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from the *Pesquisa de Orçamentos Familiares 2008-2009 (POF)*, Brazil's nationally representative household survey of income and expenditure. To rescale income and expenditure, the researchers perform a mapping of the 13,255 commodities in POF into the 10 sectors of the [EMF36](#) sectoral aggregation, assuming that each sector only produces one commodity. The expenditure structure obtained from POF is adjusted to fit the Global Trade Analysis Project (GTAP) sectors. In the TEA model, income from each production factor (capital, labour) and transfers are distributed according to the share for each household decile obtained in POF. No results are available yet of the study, but the researchers are developing simulation scenarios in line with the 36<sup>th</sup> round of the Energy Modelling Forum (EMF36) – Carbon Pricing after Paris (CarPri). EMF36 focuses on the analysis of climate policy scenarios relevant for the implementation of the Paris agreement. EMF36 includes scenarios related to the NDCs and additional efforts (e.g., 2°C targets), where policy instruments – carbon pricing, in particular – are introduced to meet emission reduction requirements. In addition to the core scenarios, the modelling groups participating in the EMF36 are encouraged to present papers on the impacts of the core scenarios on households of a particular region. The COPPE/UFRJ modelling team will use the newly developed income disaggregation method to assess the heterogeneous effects of introducing different schemes of carbon trading on the income distribution in Brazil. While most such applications rely on static national models, there are few studies that apply this method on global recursive dynamic CGE models.

## 5 Modelling developments covering the link between climate and circular economy

- An [article](#) in the journal of *Resources, Conservation and Recycling* explores the links between climate change, circular economy and carbon capture and storage (CCS) in the context of Norwegian waste-to-energy (WtE). The study integrates life-cycle assessment (LCA) with analysis of overall energy and material balances, mathematical optimization and cost assessment to evaluate the implications of a circular economy on the Norwegian WtE sector and the potential to add CCS to the sector. It assesses four scenarios: the current situation in the WtE sector, a circular economy scenario, the addition of CCS to the WtE sector, and a landfill scenario. A cost assessment of the economic outcomes of the scenarios is performed. The results show that circular economy could create opportunities for the WtE sector to develop and expand into new value chains such as secondary raw materials production.
- An [OECD working paper](#) on the macroeconomics of the circular economy transition offers a critical review of the modelling approaches used in the field<sup>3</sup>. Incorporating material flows into integrated economic-energy modelling is still a new and growing research field. The study examines 24 modelling-based assessments of the circular economy, and it draws four key conclusions: a) the transition to a circular economy will have insignificant or positive impact on aggregate macroeconomic outcomes; b) the introduction of circular economy enabling policies could have sectoral and regional re-allocation effects; c) some models are better suited to model the transition because they account for sector

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<sup>3</sup> The macroeconomic impact of resource efficiency and the circular economy were a topic of discussion for a first time at the last IAMC meeting in December 2019. The results presented at the conference show that the impact is relatively small, with a number of sectors benefiting from these actions.



interactions and macroeconomic feedbacks; and lastly, d) the outcomes of these models are strongly dependent on the model assumptions.

## 6 Other modelling developments

- A team of researchers from Japan, China and the Republic of Korea estimate the air quality co-benefits from climate mitigation for human health in the Republic of Korea in a forthcoming article in [Environment International](#) journal. The authors integrate the Asia-Pacific Integrated Assessment/Computable General Equilibrium (AIM/CGE), the Community Multiscale Air Quality modelling system CMAQ, and a health impact assessment model to assess not only the cost of climate change mitigation efforts but also their co-benefits. The health impact estimates were then combined with the Integrated Model of Energy, Environment, and Economy for Sustainable Development/Computable General Equilibrium (IMED/CGE). The results show that climate change mitigation action leads to substantial health gains, and that the benefits of these health gains and improved air quality can offset the total cost of climate mitigation in South Korea. This is one of the first studies to quantify the health-co benefits of climate mitigation for Korea which faces air quality issues.
- In a recent [article](#) in *Nature Climate Change*, a research team from Australia compare two climate modelling methods: transient climate and equilibrium climate. Through climate model simulations the authors show that for a given global temperature, land areas are significantly warmer in a rapidly warming case (i.e. transient climate modelling) than in a gradually warming case (equilibrium climate modelling). The probability of very warm seasons is at least two times greater for some poorer land regions. Most emissions and climate change targets are estimated using equilibrium climate models and hide these regional differences and may underestimate the rates of increase of global-average temperatures. The study finds that for climate change policies to be effective, they need to take into account the differences between these two modelling techniques.
- [NAVIGATE](#) – Next generation of Advanced InteGrated Assessment modelling to support climate policy making – is a new project hosted by the [European Institute on Economics and the Environment](#) funded by the European Union's Horizon 2020 programme. The project aims to improve the capability of Integrated Assessment Models (IAMs) to inform the design and evaluation of climate policies. The modelling group will focus on two areas: 1) describing transformative change in the economy, in technology and in consumer goods and services, and 2) describing distributional impacts of climate change and climate policy. No published results are available yet. The NAVIGATE project will also host a webinar series for scientists and experts to share the knowledge from the project.
- A number of methodological advances were presented and discussed at the [12<sup>th</sup> IAMC meeting](#) in Tsukuba, Japan in December 2019. A number of papers highlighted the improved representation of different technologies in IAMs (e.g. land-use technologies, bio-energy with carbon capture and storage, etc.). Other papers highlighted the need for IAMs to be combined with other analysis tools (e.g. life-cycle assessment models (LCA), models that link to air pollution, etc.). Integration of models is key to better model the interrelationship between sectors and assess pathways that meet multiple Sustainable Development Goals (SDGs). A key message from the presentations was the need for model intercomparison that would ensure transparency of assumptions and help better understand the different outcomes estimated by different models.