Climate change modelling information

Quarterly report – Q3 2020 report

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Quarterly report – Q3 2020 report

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1 High-level executive summary

This report under the “Climate change modelling information” series presents recent developments reported by key international climate modelling institutions. This issue sets a particular emphasis on the transport sector and the Covid-19 public health crisis and its effects, in addition to the regular sections on Nationally Determined Contributions and the Sustainable Development Goals.

The first section of the report features modelling developments linked to the integration of **the Covid-19 public health crisis** within climate models. With the caveat that it is too early for concrete research results, there is already some evidence that modellers are working to integrate the impacts of the crisis in their work. Researchers in the UK propose a new approach to estimating the reduction of global CO_2 emissions during the crisis by compiling a confinement index of government lockdown policies and reduction of human activities. Scientists measuring the concentration of CO_2 in the atmosphere estimate that the effect of confinement policies on CO_2 emissions will be relatively slow and will not drastically stop the build-up of CO_2 in the atmosphere. Finally, a number of researchers form the Union of Concerned scientists issued a warning about the need to address compound climate risks in the Covid-19 and future pandemics.

Various developments linked to the implementation of the **Nationally Determined Contributions (NDCs)** are reported on in the second section. Two recent studies assess the impact of national climate policies on reaching the Paris Agreement targets – one study does that for the seven highest CO_2 global emitters and one study focuses on China. Another study from researchers in China examines the climate and health benefits of phasing out iron and steel production. The authors of the study have compiled a new database of steel plants in the Beijing-Tianjin-Hebei region. The section also presents a new integrated assessment model developed at provincial level in South-Korea. Finally, a recent article examines the effects of a potential international emissions trading system in China, South-Korea and Japan.

The third section of the report is dedicated to developments linked to the **Sustainable Development Goals (SDGs)**. A study from the European Commission’s Joint Research Centre examines the economic value of health-related air quality benefits of climate policy. And – also from the JRC – a new dataset of bridging matrices allows for better combining micro-level consumption and nation-level production statistics in 30 European countries.

In the fourth section, the report features research linked to the **representation of the transport sector** in climate policy. Two key themes emerge from the developments in this section: the need to integrate models of the transport and energy systems and the need to better represent human behaviour in transport models. Two review articles asses the tools used to model human behaviour in mobility systems, one from the USA and another from Denmark. Another study from Denmark examines the long-term decarbonisation of the transport sector in Denmark. And finally, an article from the JRC analyses the policy options for promoting fuel cell electric vehicles in the EU to drive the reduction of CO_2 emissions in the transport sector.

2 Introduction

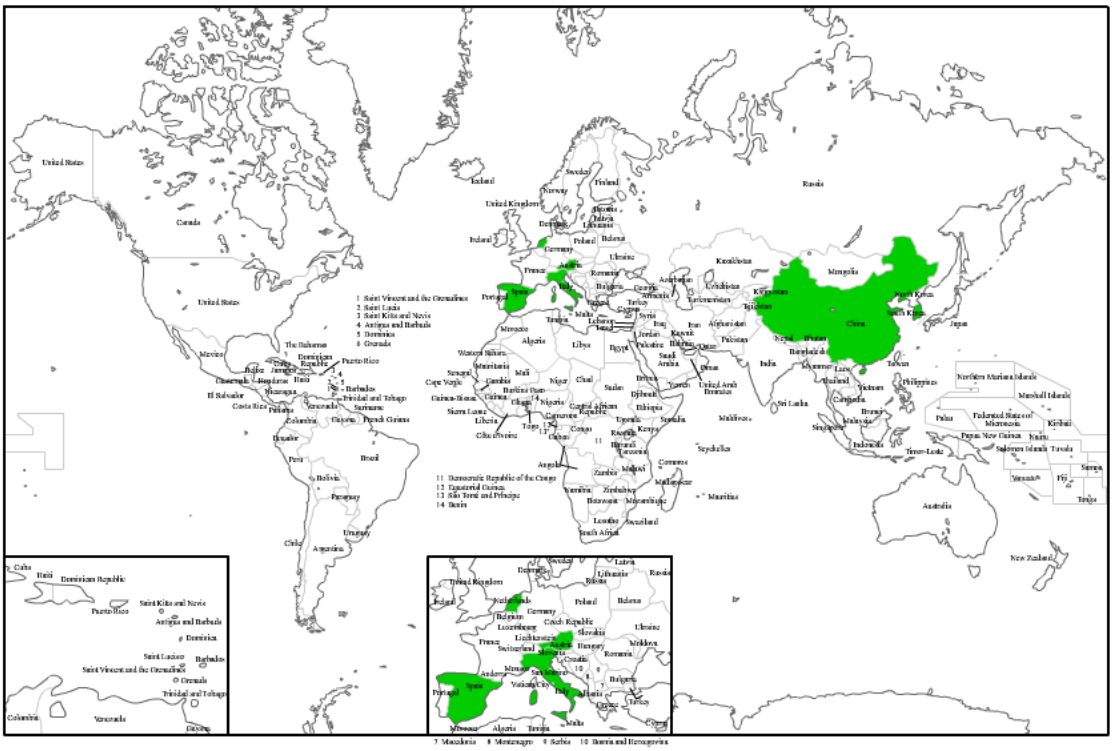
This report is the third quarterly report of 2020 under the series “Climate change modelling information” financed by the European Commission. The objective of this series is to inform the European Commission and the wider climate change and energy modelling community about recent and relevant modelling developments.

The data presented in this report were collected through an open survey sent to more than 200 modelling teams worldwide and open from 12 to 25 May 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 the transport sector in climate models. In light of the Covid-19 crisis, an additional set of questions was asked about whether modellers are integrating the impact of Covid-19 in current policy scenarios and in economic recovery plans. Only two modellers – both from public institutes – responded that such work is undergoing. 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), 8 different organisations and covered 8 different modelling developments and projects.

Additional research was undertaken to complement the survey results.

Figure 2.1 Geographical coverage of climate change modelling developments reported through the online survey (n = 8)



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 integration of the Covid-19 public health crisis:

- New approach for estimating the reduction of global CO_2 emissions during the Covid-19 crisis (UK)
- Overall amount of CO_2 in atmosphere continues to raise (UK)
- Compound climate risks in the Covid-19 pandemic (USA)
- Impact of Covid-19 on Dutch GHG emissions (Netherlands)

Modelling developments linked to nationally determined contributions (NDCs):

- Taking stock of the impact of national climate policies to evaluate the implementation of the Paris Agreement (Netherlands)
- The climate and health benefits of phasing out iron and steel production capacity in China (China)
- New database of steel plants in the Beijing-Tianjin-Hebei region (China)
- Carbon markets cooperation in Korea, China and Japan (Republic of Korea)
- New Integrated Assessment Model GCAM-Korea at the provincial level (Republic of Korea)
- Integrated assessment for achieving the 2ºC target pathway in China by 2030 (China)

Modelling developments linked to Sustainable Development Goals (SDGs):

- The economic value of health-related air quality co-benefits of climate policy (Spain)
- New dataset of bridging matrices for combining micro-level consumption and national-level production statistics in 30 European countries (Spain)

Modelling developments linked to the representation of the transport sector:

- Assessment of the methodological tools used to model future mobility systems and their connections with the energy systems (USA)
- Review of modelling techniques used to represent consumer behaviour in integrated energy and transport models (Denmark)
- Representing human behaviour in modelling the long-term decarbonisation of the transport sector (Denmark)
- Policy strategies for promoting fuel cell electric vehicles in the EU (Spain)

3 Modelling developments linked to the integration of the Covid-19 crisis

- In the context of the Horizon 2020 Paris Reinforce project, researchers from the University of East Anglia, University of Exeter, University of Groningen, Stanford University, CICERO Center for International Climate Research, the Mercator Research Institute on Global Commons and Climate Change, and the Global Carbon Project have published an article in *Nature Climate Change* introducing a new approach to estimating the reduction of global CO_2 emissions during the Covid-19 public health crisis. Despite the number of news reports on the reduction of CO_2 emissions since the beginning of the crisis, there is no reliable, real-time data on emission reductions. Most research uses emissions data reported by countries, but they report CO_2 emissions annually – and usually with a substantial lag. Daily concentrations of CO_2 in the atmosphere are available in real time, but they are affected by variations in the natural carbon cycle and meteorological events. Therefore, they cannot be used to measure emissions reductions due to the Covid-19 crisis. To solve this data availability problem, the authors compile government policies on confinement and human activity data to help estimate CO_2 emissions reductions during the crisis – the Confinement Index (CI). The CI covers changes in activity across six economic sectors (i.e. power, industry, public buildings and commerce, residential and aviation) and

policies such as bans of public gatherings, mandatory closures of schools, restaurants, and public buildings, border closures, etc. The key finding is that daily global CO_2 emissions decreased by 17% by early April compared with 2019, and almost half of this reduction is due to changes in land transport activities. The overall level of decrease for 2020 will depend on the duration and extent of confinement policies. Most importantly, these changes in emissions levels are likely to be temporary if no structural economic, energy and transport changes occur.

- New analysis by the scientists at the national meteorological services in the UK and the Scripps Institution of Oceanography shows that despite the Covid-19 related changes in activity, the amount of CO_2 in the atmosphere is expected to rise in 2020. The researchers estimate that the annual average CO_2 concentrations will rise by 2.48 parts per million (ppm) in 2020, only 0.32ppm (or 11%) less than if there were no confinement. Another estimate from the IEA is for just an 8% annual decline in GHG emissions. The key message is that even if CO_2 emissions have temporarily reduced, they are still accumulating in the atmosphere. To slow down climate change, GHG emissions will have to slow down much more radically and permanently.
- Researchers from the Union of Concerned Scientists have published a comment in *Nature Climate Change* on the compound climate risks in the Covid-19 pandemic. The article warns about the upcoming climate hazards such as heat waves, wildfires, floods, droughts and hurricanes that are likely to occur during the Covid-19 pandemic, and it emphasises the need for a coordinated response across agencies and sectors to the unfolding public health crisis and the ongoing climate crisis. The authors urge for the creation of a pandemic preparedness strategy for climate adaptation that would allow the international community to address the compound risks of future pandemics and climate crises.
- At PBL Netherlands, researchers are working on integrating the impact of the Covid-19 crisis in their Integrated Assessment model calculations. They are trying to estimate the impact of Covid-19 on current policies projections based on ex-ante calculations. This is still work-in-progress given the large uncertainties related to the Covid-19 crisis. In parallel PBL also published a report on the impact of the Covid-19 crisis on the Dutch GHG emissions. Based on two scenarios of the impact of the crisis on the Dutch economy developed by the Netherlands Bureau for Economic Policy Analysis (one positive planning for a recovery by end 2020 and one more negative), the report assesses the potential impact of the crisis on emissions from the transport and mobility sector, industry, buildings, agriculture and electricity demand. It concludes the crisis will mainly impact the emissions from the industrial sector, transport and electricity demand, while the impact will be minimal in the agricultural sector and no decrease is expected in the building sector.

4 Modelling developments linked to Nationally Determined Contributions (NDCs)

- A recent article in *Nature* takes stock of the impact of national climate policies to evaluate the implementation of the Paris Agreement. Researchers from institutes around the world have collaborated in a unique multi-model study to assess the impact of current climate policies. The study focuses on emission trends up to 2030 in seven countries and regions jointly responsible for the majority of global GHG emissions (i.e. Brazil, China, the EU, India, Japan, the Russian Federation, and the USA). In total, five scenarios are evaluated: a “no new policies or business-as-usual scenario, an NDC scenario (full

implementation of conditional national NDCs), and 2 °C and 1.5 °C scenarios. The study also calculates an “implementation gap”, i.e. the difference between the impact of implemented and planned national policies up to 2017 and the NDCs, and an “ambition gap”, i.e. the difference between the impact of the NDCs and well below 2 °C emission pathways. The scenario analysis performed by the models shows that in order to meet the global target of the Paris Agreement in a cost-optimal way, a 40%–50% reduction in global emissions is required by 2030 relative to the national policies scenario and compared to 2010. They found that the impact of the analysed policies would reduce GHG emissions by 2.5 to 5.0 Gt CO_2e by 2030 (median 3.5 Gt CO_2e) or 5.5% (4%–8%), compared to a situation where no climate policies and targets would have been implemented. The actual reductions fall significantly short of those pledged in the NDCs. If implemented, those policies would lead to an additional reduction of about 5 to 10 Gt CO_2e (median of the models is 7.7 GtCO_2e), equalling an emission reduction of about 17% (15%–22%) by 2030, compared against a scenario without emission reductions. So, although the study shows that policies are indeed being implemented, it also identifies a large gap between the Paris goal and countries' pledged contributions, and an even larger gap with the actual implemented policies. A delay in action would either lead to additional costs or failure to achieve the Paris goal. The gap by 2030 is estimated to be around 22–28 Gt CO_2e. In order to achieve the targets, all countries should accelerate the implementation of policies regarding renewable technologies and energy efficiency improvements.

- A research team at the Laboratory of Energy and Environmental Economics and Policy (LEEEP) at Peking University reported on a forthcoming article in *Climate Change Economics* on the climate and health benefits of phasing out iron and steel production capacity in China. The research expands and soft-links between air quality model (GAINS) and IMED models to characterize the impacts of climate change and PM2.5-attributed health co-benefits of phasing out iron & steel (IS) production capacity in the Beijing-Tianjin-Hebei region in China. The authors find that the production capacity phase-out policy (PCPP) based on scale limitation to eliminate outdated production capacity in the region yields total benefits of 34.9 billion Yuan (4.2 billion USD), 89% of which coming from energy saving and carbon mitigation, more than policy costs (20.0 billion Yuan) in 2020. However, the gap between the benefits and the costs will keep narrowing to -2.8 billion Yuan (-0.3 billion USD) in 2020-2030, indicating that policy improvement is needed in the long run. To further increase policy co-benefits and achieve multiple policy targets, policymakers should readjust the production capacity phase-out policy by favouring energy efficiency constraints instead of reducing production capacity (notably through furnace scale limitation). If doing that, the difference of benefit-cost will achieve 42.5 billion Yuan (5.1 billion USD). The regional disparity also exists due to the diverse ratio of benefit-cost in the selected provinces, calling for necessary fiscal incentives to the less developed area, e.g., Hebei, to promote closer integration. The article is relevant to multiple sustainable development goals, the NDCs and air pollutant emission targets and could better support local climate policy-making.
- The same research group at Peking University has developed a new database of steel plants in the Beijing-Tianjin-Hebei region. The database contains information on 65 ongoing steel plants, accounting for about 67.3% of total crude steel capacities and 73.1% of pig iron capacities in the region. This database includes detailed information about each steel plant, including the general information about plants (e.g., location, opening year and activity levels), the quantity of industrial furnaces, consumption of main raw materials including energy, and output of various iron & steel (IS) products. The database was

developed with the support of China's environmental departments and steel industry experts. For more information consult the LEEEP research group's website.

- In a forthcoming article in *Climate Change Economics*, researchers from Ajou University in the South-Korea and the National Center for Climate Change Strategy and International Cooperation in China examine how carbon market cooperation changes the energy system in Northeast Asia. The article analyses the impact of a potential international emissions trading (IET) system between South Korea, China and Japan, the expected gains from emissions trading in such a system, and the role of IET for achieving NDCs. The results show that mutual benefits from emissions trading are expected for all three countries. The article also flags that although an IET system might incentivises China to shift to more renewable energy and carbon capture and storage (CCS) technologies, it might push Japan and Korea to increase their use of conventional fossil fuels over renewable energy sources. This might happen because importing CO_2 permits will lower the marginal domestic CO_2 abatement costs in Korea and Japan. Therefore, it is necessary to design such an IET system carefully since the consumers (importers) of pollution permits such as Korea and Japan might face less incentives to transition to clean energy.
- A new provincial-level energy system model is available for the Republic of Korea. The new GCAM-Korea model was developed by researchers at Ajou University and is based on the global change assessment model (GCAM) for the USA. It contains energy and socioeconomic data for 16 of the 17 Korean provinces. Results from the model have been validated as compatible with historical trends. More information about the model and how to access it is available in the recent article in *Energies*.
- Researchers at the Beihang University and Peking University in Beijing have published an integrated assessment for achieving the 2°C target pathway in China by 2030. They used the dynamic CGE model developed by the LEEEP research group to build ten scenarios varying in the stringency levels of carbon emissions limitations and the availability of different low-carbon options. The results show that the development of non-fossil fuel such as renewable and nuclear power would be the dominant, most effective contributors to reducing the carbon emissions to meet the NDC targets. Furthermore, to achieve the 2°C target, an additional 3.9 Gt CO_2 of carbon reduction is needed by 2030. Beyond the development of non-fossil energy sources, other measures such as electricity saving and improving power efficiency could contribute to 40.5% of the total carbon reduction required by 2030 while CCS technologies could contribute to 8.9% of this effort. In addition, the researchers also found that demand side actions such as promoting low-carbon household lifestyles would be important. The article is available in the *Journal of Cleaner Production*.

5 Modelling developments linked to Sustainable Development Goals (SDGs)

- New research from the European Commission's Joint Research Centre (JRC) quantifies the economic value of health-related (premature mortality) air quality co-benefits of climate policy. It does so by combining atmospheric chemistry modelling with integrated energy systems models. This approach enables to come up with a monetary co-benefit value ($ 2015 per tonne of CO2e) by multiplying air pollutant emissions (expressed in PM2.5-equivalent emissions) with their corresponding region- and pollutant-specific health impact cost. A range of results is presented across a set of integrated assessment models,

building on the scenario ensemble of the 30th Energy Modelling Forum (EMF). While on the global level the air quality co-benefits range from USD 8 to USD 40 per tonne of GHG abated in 2030, there are strong variations across regions and sectors. For example, the co-benefits in the residential and service sectors in India exceed USD 500 per abated tonne. This information may help identify synergetic actions and point out opportunities to ratchet up climate ambition while improving human health simultaneously. The article is available online in the journal of *Climatic Change*.

- The JRC has also made available a new dataset that allows to bridge micro-level consumption and national-level production statistics. The dataset represents a set of bridging matrices that allow combining economy-wide input-output tables (in products by activity (CPA) classification) with micro-level household budget surveys (in consumption by purpose (COICOP) classification). Making these tables publicly available may facilitate connecting different tools and datasets to analyse how the carbon content of consumption differs across household types and income groups. They will be useful for CGE and input-output models and for carbon footprint and life cycle analysis. The published bridge matrices form one necessary piece in a modelling toolbox that can analyse distributional impacts of climate policy driven by differences in consumption patterns. The dataset covers 30 European countries and it is available online in the journal *Data In Brief*.

6 Modelling developments covering the representation of the transport sector

- In a recent article in *Renewable and Sustainable Energy Reviews*, researchers from the National Renewable Energy Laboratory in the USA assess the methodological tools used to model future mobility systems and their connections with the energy systems. The authors find that current models of energy and transport systems are not well represented and integrated within each other and that the links between the systems are under-modelled. They find that transport and energy systems models do not sufficiently represent human behaviour (e.g. consumer choice), especially at the household-level. They identify four key areas for future research to improve the modelling for future transport-energy systems: emerging transport trends, the locus of consumer choice, multi-sectoral dynamics, and spatiotemporal resolution.
- An article from researchers at the Technical University in Lyngby, Denmark, and University College Cork, Ireland, reviews the integrated energy and transport models which contain a detailed description of the passenger transport sectors to identify possible avenues for improvements in the representation of consumer behaviour. The authors find that a high level of integration of the energy and transport sectors is a precondition for incorporating consumer behaviour in the models. The main contribution of the paper is the analysis of the modelling methodologies used to incorporate human behaviour in passenger transport. Although this article dates back to July 2018, it is worth mentioning in this report as it reviews numerous methodologies for incorporating human behaviour related to transportation, in energy–economy–environment (E3) models.
- Another article in *Energy Policy* by researchers at the Technical University in Denmark emphasises the importance of representing human behaviour in modelling the energy, economy, environment, engineering nexus. The researchers use the integrated energy system model TIMES-DK to analyse the long-term decarbonisation of the transport sector in Denmark. They extend the representation of transport modes shift by aggregating passenger model travel demands into the demand segments based on the distance range. They find that

less strict travel time budget (more flexibility for average daily travel time per individual) and increased speed of public buses lead to a more efficient decarbonisation of the Danish transport sector by 2050.

- Researchers from the JRC have published an article on the potential policy strategies for promoting fuel cell electric vehicles (FCEV) by overcoming their initial high capital expenditure. The transport sector is the only sector which continues to increase its CO_2 emissions relative to 1990, and emissions reductions in this sector could have a substantial impact on meeting EU climate targets. The authors employ a soft-linking of a behavioural model for the passenger transport sector with energy system cost optimisation applied to hydrogen in the EU. The two models used in the study are the JRC-EU-TIMES model of energy systems and the Powertrain Technology Transition Market Agent Model (PTTMAM) which covers manufactures, users, infrastructure providers and authorities. The key finding is that the policy with the largest net impact to promote FCEV deployment is a vehicle discount by manufacturers of EUR 5,000 per vehicle between 2030-2034 across the EU28.