Targeted green recovery measures in a post-COVID-19 world enable the energy transition

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# Supplementary Data 1: Models

The analysis involves developing the capacity of a suite of quantitative models and using them to analyze actual and potential global climate change policies, and to assess the adequacy of greenhouse gas emission development strategies. A key contribution is the development of model-based mitigation scenarios at the level of different countries and regions from global integrated assessment models, macro-economic models. Three models are used to analyze economic, energy system and environmental implications of global change mitigation pathways. The models that can be used for this purpose include:

**IMAGE model**

PBL’s **IMAGE** modelling framework, which is an integrated assessment model framework that simulates the environmental consequences of human activities worldwide1–3. The IMAGE scenarios analyzed here are all based on the IMAGE implementation of the SSP2 scenario (no policy baseline)2, which is the IMAGE baseline scenario in the analysis. The SSP2 scenario describes a middle-of-the-road scenario in terms of economic and population growth and other long-term trends such as technology development. The main drivers of this scenario for the energy and industry sectors are population, gross domestic product (GDP), lifestyle and technology change. The IMAGE current policies scenario was derived from the original SSP2 baseline by introducing explicit policy measures and is reported in detail in Roelfsema et al.4. This scenario assumes that current policies are implemented up until 2030. For the period 2030-2100 the scenario assumes no new policies. Policies may have a long-term effect through the induced technology learning effects (e.g. by additionally installed renewable energy technologies compared to the SSP2 baseline). Mitigation efforts in the land use sector assume an implementation of a low carbon tax in the sector, to enhance REDD and to increase reforestation of half of the degraded forest, as described in more detail in Doelman et al.5.

In terms of mitigation in the energy system, TIMER covers a wide range of mitigation options, including nuclear power, renewable energy (different solar and wind technologies, hydropower), bio-energy (first and second generation), nuclear power and CCS technology.

The model further represents all sectors and greenhouse gases, with a relatively detailed representation of mitigation policies beyond carbon taxes (existing and potential new policies)4,6, and good coverage of SDG-related processes (e.g. sustainable development, air quality, energy access, land use, water management)7,8. A detailed description of the IMAGE model is presented on: [www.pbl.nl/image](http://www.pbl.nl/image) ; and in the following key publications1–3.

**E3ME** **model**

Cambridge Econometrics’ **E3ME** model (for assessing the economic consequences of climate policy, including the uptake of energy technologies);

E3ME is a global, macro-econometric model designed to address major economic and economy-environment policy challenges. Developed over the last 25 years, it is one of the most advanced models of its type. Its strengths are:

* A high level of disaggregation (70 sectors in 61 countries/regions), enabling detailed analysis of sectoral and country-level effects from a wide range of policy inputs. All EU and G20 countries are represented explicitly. Social impacts (including unemployment levels and distributional effects) are important model outcomes.
* Its econometric specification addresses concerns about conventional macroeconomic models and provides a strong empirical basis for analysis. It can fully assess both short and long-term impacts and is not limited by many of the restrictive assumptions common to Computable General Equilibrium (CGE) models.
* Integrated treatment of the world’s economies, energy systems, emissions and material demands. This enables it to capture two-way linkages and feedbacks between these components. The integrated FTT models of technology diffusion (for the power sector, steel sector, household heating and passenger vehicles) allow for a detailed analysis of the interaction of technology policy and rates of adoption.

A detailed description of the E3ME model given is given in Appendix A.2, [www.e3me.com](http://www.e3me.com) ; and in the model manual9. A full list of equations may be found in the supplementary information of Mercure et al.10 and a description of the model’s post-Keynesian framework and financial sector in Pollitt and Mercure11. The FTT models are described in Mercure12, Mercure et al.13 and Knobloch et al.14, and Cambridge Econometrics9.

**GEM-E3-FIT model**

E3Modelling P.C.’s **GEM-E3-FIT** model is used for assessing the socio-economic, industrial, trade and distributional consequences of energy and climate policies at national, regional and global levels, including the development of clean energy technologies.

The GEM-E3-FIT model is an advanced and detailed applied Computable General Equilibrium (CGE) model, simultaneously representing 46 countries/regions, including all EU-28 countries individually and the largest economies globally (USA, Japan, Canada, Brazil, China, India, South Korea, Indonesia, Mexico, Argentina, Turkey, Saudi Arabia, Oceania, Russian federation, Energy producing countries, South Africa, Rest of OECD, Rest of the World). GEM-E3-FIT covers the interactions between the economy, the energy system and the environment. It is a comprehensive model of the economy, covering the interlinkages between productive sectors, consumption, price formation of commodities, labour and capital, bilateral trade and investment dynamics. The model is dynamic, recursive over time, driven by accumulation of capital and equipment. Technology progress is explicitly represented depending on learning-by-doing and R&D expenditure by private and public sector and spillover effects. The model features alternative market regimes, discrete representation of power producing technologies, equilibrium unemployment, energy efficiency standards, carbon pricing and formulates emission permits for GHGs. GEM-E3-FIT can quantify the macro-economic, social, employment and distributional impacts of specific environmental and energy policies. The most important results, provided by GEM-E3-FIT, are:

1. dynamic annual projections of national accounts by country;
2. full Input-Output tables by country;
3. distribution of income and transfers in the form of a social accounting matrix by country,
4. employment by economic activity and by skill and unemployment rates;
5. capital and investment by country and sector;
6. CO2 and GHG emissions by country, sector and fuel;
7. consumption matrix by product and investment matrix by ownership branch;
8. full bilateral trade matrices among all countries and sectors;
9. energy demand and supply by sector and fuel, power generation mix, deployment of transport technologies energy efficiency improvements.

# Supplementary Data 2: Implementation of COVID-19 impact in the IMAGE model

**COVID scenario**

IMAGE’s economic activity drivers are the GDP per capita, Personal Consumption per capita, and the Value Added for the following economic sectors: Industry (IVA), Services (SVA) and Agriculture (AVA) per capita. The information on economic activity drivers comes from the World Bank’s World Development Indicators for the historic period. It is transformed into per capita values based on population data from the United Nations up to 2019 are available for each country. The values are then projected to 2100 using the SSP scenario growth rates established by GDP scenarios15 and population projections consistent with the SSP storylines.

In collaboration with the E3ME and GEM-E3-FIT macroeconomic models, updated GDP and added value projections were calculated, using the data from the OECD Economic Outlook from September 202016 (for non-EU countries, if available), the IMF World Economic outlook from June 202017, the World Bank Global Economic prospects report from June 202018 and the Autumn Economic Forecast from November 202019 (for EU countries), for the years 2020 to 2025. The Reference scenario growth rates resumed from 2026 onwards.

**Sectoral activity levels**

While IMAGE is partly steered by macro-indicators such as income and GDP, long-term policies, and structural changes, the calculated impact of the macro-economic indicators changes is not enough to capture the pandemic's full effect on sectoral activity levels and the related CO2 emissions. The sharp drop in aviation activity, road transport and industry was not so much a result of GDP loss but of strict lockdown measures or behavioral changes – flight and surface transport restrictions, decline in demand and production and teleworking increase. To accurately capture the activity levels in different sectors, the reduction in activities was calculated based on respective data sources. Consequently, the IMAGE model calculations were adjusted to simulate the additional drop in activity levels (on top of the activity level drop due to GDP loss) in 2020 and the projections for the short-term future activity levels. Detailed information on the improvement introduced for each sector can be found below. The changes in energy and electricity supply are assumed to be adequately proxied via the decline in demand through the industry, transport, residential and service buildings sectors.

**Aviation**

The IMAGE model uses, among other variables, passenger kilometers (PKM) as a way of calculating traffic demand. One of the main drivers is the GDP per capita changes. As indicated above, in the case of the COVID-19 pandemic, the drop in income is not an accurate representation of the actual drop in **aviation activity**, and so an additional adjustment  was required as a correction factor due to the pandemic's effect on airline traffic20–22.

These airline traffic data is on a continental level (except the Middle East that was considered a separate region) and converted to the 26 individual IMAGE regions (see below). Specifically, for China, data were taken from the National Bureau of Statistics of China23 in RPK. RPK is an airline industry metric that shows the number of kilometers travelled by paying passengers and is calculated as the number of revenue passengers multiplied by the total distance travelled. It is one of the main variables the IMAGE model uses to calculate aviation traffic demand. The projections for 2022 are calculated based on the assumption that aviation traffic returns to normal rates20,24. The Table below presents the RPK percentage change on a Year-on-Year basis.

|  |  |  |  |
| --- | --- | --- | --- |
| **Aviation traffic activity levels [RPK YoY %]** | | | |
|  | **2020** | **2021** | **2022** |
| **Canada** | -66 | 60 | 3 |
| **USA** | -66 | 60 | 3 |
| **Mexico** | -64 | 39 | 12 |
| **Rest C. America** | -64 | 39 | 12 |
| **Brazil** | -64 | 39 | 12 |
| **Rest S. America** | -64 | 39 | 12 |
| **N. Africa** | -72 | 35 | 18 |
| **W. Africa** | -72 | 35 | 18 |
| **E. Africa** | -72 | 35 | 18 |
| **South Africa** | -72 | 35 | 18 |
| **W. Europe** | -70 | 47 | 11 |
| **C. Europe** | -70 | 47 | 11 |
| **Turkey** | -70 | 47 | 11 |
| **Ukraine** | -70 | 47 | 11 |
| **Stan** | -62 | 50 | 6 |
| **Russia** | -70 | 47 | 11 |
| **M. East** | -73 | 43 | 15 |
| **India** | -62 | 50 | 6 |
| **Korea** | -62 | 50 | 6 |
| **China** | -49 | 31 | 15 |
| **SE. Asia** | -62 | 50 | 6 |
| **Indonesia** | -62 | 50 | 6 |
| **Japan** | -62 | 50 | 6 |
| **Oceania** | -62 | 50 | 6 |
| **Rest S. Asia** | -62 | 50 | 6 |
| **Rest S. Africa** | -72 | 35 | 18 |

**Surface transport**

The activity correction factor for **surface transport** was based on the Google Mobility database25,26. It provides the change in the number of visitors split between retail and recreation, grocery and pharmacy, parks and outdoor spaces, workplaces and transit stations.  The important steps and assumptions are outlined below to convert the reduced number of visitors to road traffic.

First, it is assumed that the same percentage of the population uses a car for all of the above types of activities, based on relative data for each region27,28,37–39,29–36. This means that people who use a personal vehicle to go to work will also use it for grocery, retail and recreation trips. In the next step, the use of a personal vehicle between the above activities is assumed to be: 75% use for commuting purposes, 20% for retail, grocery and pharmacy trips, and 5% for day trips/outdoor visits39,40. The aggregate of these results represents the total reduction in car use, which is assumed to be equal to the reduction in PKM year-on-year (YoY) percentage change. Similar to aviation traffic, data for China were taken from the National Bureau of Statistics of China23, directly in PKM reduction. In collaboration with the consortium, normal traffic patterns are assumed to return to normal in 2022.

|  |  |  |
| --- | --- | --- |
| **Surface transport activity levels [PKM YoY %]** | | |
|  | **2020** | **2021** |
| **Canada** | -18 | 13 |
| **USA** | -21 | 15 |
| **Mexico** | -17 | 12 |
| **Rest C. America** | -17 | 12 |
| **Brazil** | -11 | 8 |
| **Rest S. America** | -20 | 14 |
| **N. Africa** | -8 | 6 |
| **W. Africa** | -9 | 6 |
| **E. Africa** | -8 | 6 |
| **South Africa** | -13 | 9 |
| **W. Europe** | -16 | 11 |
| **C. Europe** | -10 | 7 |
| **Turkey** | -12 | 9 |
| **Ukraine** | -9 | 6 |
| **Stan** | -14 | 10 |
| **Russia** | -10 | 7 |
| **M. East** | -25 | 18 |
| **India** | -16 | 11 |
| **Korea** | -2 | 2 |
| **China** | -46 | 33 |
| **SE. Asia** | -15 | 10 |
| **Indonesia** | -15 | 11 |
| **Japan** | -4 | 3 |
| **Oceania** | -13 | 9 |
| **Rest S. Asia** | -14 | 8 |
| **Rest S. Africa** | -5 | 4 |

**Industry**

Three sectors in the IMAGE industry module are looked at: steel, cement and other industry (including the rest of the industrial sector).  The industrial activity level in IMAGE is presented as material demand related to economic activity and material intensity for steel and cement. Based on demand for materials, the production is determined and the related use of energy and the and subsequent emission. The activity correction factors were implemented in either the material demand level or the material production level, depending on the data availability. The activity level in the **steel** industry is based on the World Steel Association data41, with the regional steel demand in 2020 and forecasts for 2021. Most of the regions have decreased steel demand in 2020 (-6% to -20% compared to 2019), except for China (+8%), Turkey (+10%) and the Oceania region (+2.1%). In 2021, all the regional projections increased compared to 2020 levels (+2.5% to +11%), besides China, which remains at the same demand level as 2020. The activity level for steel is assumed to return to the SSP2 level in 2022.

For the **cement** activity levels, data from the IFC42 (International Finance Corporation) were used, providing information on cement production changes in 2020 compared to 2019. The same assumption as in steel is applied here as well, namely that activity levels return to SSP2 levels in 2022.

For the **rest of the industry**, OECD43 data were used, which provide the industrial production levels in Q1 to Q2/Q3 2020 for the OECD countries. The assumption was made that the 2020 activity levels equal the average of these two or three seasons. For non-OECD regions, we apply the national data from China, Mexico, India, Ukraine, South Africa, Kazakhstan, Chad, Egypt, Nepal and Bangladesh, and use them as proxy data for the TIMER regions44. Similar to cement and steel, activity levels ar~~e~~ assumed to return to SSP2 rates in 2022. There are three regions without available data: The rest of Central America, Eastern Africa and the Rest of Southern Africa, for which the original SSP2 activity levels were assumed in these cases.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Industry activity levels [YoY %]** | | | | | | |
|  | Steel demand | | Cement production | | Industrial production | |
|  | **2020** | **2021** | **2020** | **2021** | **2020** | **2021** |
| **Canada** | -16 | 7 | -3 | 1 | -9 | 3 |
| **USA** | -16 | 7 | -1.50 | -1 | -8 | 2.5 |
| **Mexico** | -13 | 7 | -6 | 2 | -12 | 4 |
| **Rest C. America** | -10 | 8 | -6 | 2 | 0 | 0 |
| **Brazil** | -10 | 8 | -6 | 2 | -7.5 | 2.5 |
| **Rest S. America** | -10 | 8 | -6 | 2 | -2 | 1 |
| **Northern Africa** | -16 | 9 | -7 | 2 | -15 | 5 |
| **Western Africa** | -16 | 9 | 0 | 0 | 8 | -3 |
| **Eastern Africa** | -16 | 9 | 0 | 0 | 0 | 0 |
| **South Africa** | -16 | 9 | 0 | 0 | -14 | 5 |
| **W. Europe** | -15 | 11 | -8 | 3 | -10 | 3 |
| **C. Europe** | -15 | 11 | -6 | 2 | -8 | 3 |
| **Turkey** | 10 | 12 | -5 | 2 | -2 | 1 |
| **Ukraine** | -9 | 5.5 | -5 | 2 | -7 | 2 |
| **Stan** | -9 | 5.5 | -5 | 2 | -1 | 0 |
| **Russia** | -8.5 | 5 | -5 | 2 | -3.5 | 1 |
| **M. East** | -19.5 | 6 | -7 | 2 | 6 | -2 |
| **India** | -20 | 23 | -10 | 3 | -15 | 5 |
| **Korea** | -8 | 4 | -1 | 0.5 | -1 | 0 |
| **China** | 8 | 0 | -10 | 3 | 3 | -1 |
| **SE. Asia** | -6 | 6 | -5 | 2 | -2 | 1 |
| **Indonesia** | -6 | 6 | -5 | 2 | -2 | 1 |
| **Japan** | -20 | 8 | -1 | 0.5 | -11 | 4 |
| **Oceania** | 2 | 2.5 | -7 | 2 | -4 | 1.5 |
| **Rest S. Asia** | -6 | 6 | -5 | 2 | -2 | 1 |
| **Rest S. Africa** | -16 | 9 | 0 | 0 | 0 | 0 |

**Buildings**

The buildings sector in the IMAGE is separated into the residential and service buildings sectors. Data for the **residential** buildings sector were taken from the Google Mobility database25,26. They provide a change in the amount of time spent in one’s residence. Since data were not available for China, the data for Hong Kong were used as a proxy.

The main assumption for this sector is that the time spent indoors (in percentage increase) leads to an increase in energy demand for heating and cooling (depending on the region we are investigating), while the rest of the residential profile remains the same; changes in lighting, cooking and appliances are assumed to be negligible compared to heating and cooling demand changes. Residential consumption patterns are assumed to return to pre-COVID levels in 2022.

Due to limited data availability, a uniform approach was selected for the **services** sector. According to early studies, a decrease in consumption was applied in all regions, showing that service buildings have witnessed a decrease in energy consumption, although not as significant as in other sectors. This is due to the fact that service buildings have a high baseload demand to prevent mold and humidity building up in the HVAC systems, security systems needing to operate continuously, and servers kept functioning at all times45–49. Service buildings consumption patterns are assumed to return to pre-COVID levels in 2022.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Building sector activity levels  [Energy consumption YoY %]** | | | | |
|  | Residential | | Services | |
|  | **2020** | **2021** | **2020** | **2021** |
| **Canada** | 11 | -8 | -25 | 18 |
| **USA** | 9 | -7 | -25 | 18 |
| **Mexico** | 13 | -9 | -25 | 18 |
| **Rest C. America** | 13 | -9 | -25 | 18 |
| **Brazil** | 11 | -8 | -25 | 18 |
| **Rest S. America** | 16 | -11.5 | -25 | 18 |
| **N. Africa** | 8 | -5.5 | -25 | 18 |
| **W. Africa** | 13.5 | -10 | -25 | 18 |
| **E. Africa** | 13 | -9.5 | -25 | 18 |
| **South Africa** | 16 | -11 | -25 | 18 |
| **W. Europe** | 10 | -7 | -25 | 18 |
| **C. Europe** | 5 | -3.5 | -25 | 18 |
| **Turkey** | 7 | -5 | -25 | 18 |
| **Ukraine** | 5 | -4 | -25 | 18 |
| **Stan** | 5 | -4 | -25 | 18 |
| **Russia** | 2 | -1.5 | -25 | 18 |
| **M. East** | 13.5 | -10 | -25 | 18 |
| **India** | 15 | -11 | -25 | 18 |
| **Korea** | 4 | -3 | -25 | 18 |
| **China** | 12 | -9 | -25 | 18 |
| **SE. Asia** | 13 | -9 | -25 | 18 |
| **Indonesia** | 11 | -8 | -25 | 18 |
| **Japan** | 7 | -5 | -25 | 18 |
| **Oceania** | 9 | -7 | -25 | 18 |
| **Rest S. Asia** | 10 | -7 | -25 | 18 |
| **Rest S. Africa** | 4 | -3 | -25 | 18 |

# Supplementary Data 3: Green Recovery scenario implementation

The green stimulus as assumed in the **GEM-E3-FIT** model is split into (i) 33% electricity (of which 80% renewable subsidies, 20% grid investment); (ii) 33% for the promotion of electric vehicles (EVs) via subsidies to consumers; (iii) 30% energy efficiency in buildings through targeted subsidies to consumers; and (iv) 4% energy efficiency in industries. The first two measures are modeled as subsidies in the electricity and transport modules of GEM-E3-FIT50. Energy efficiency in buildings is represented using cost assumptions and sectoral split of expenditure from the PRIMES model51. To reflect the current market situation with available low-cost financial resources in the system, we assume that the recovery measures do not crowd out investment from other sectors52 with loans to finance these measures paid back after 2030.

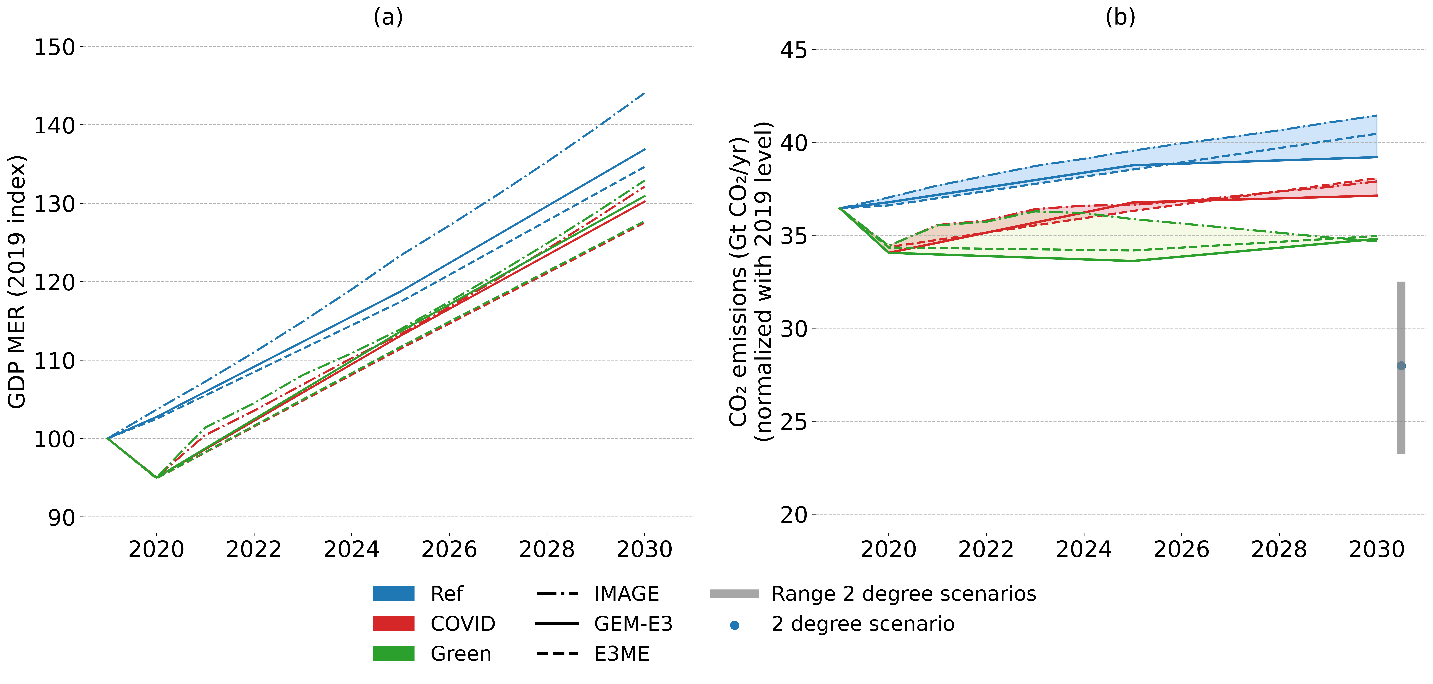
The green stimulus as assumed in the **E3ME** model is split into (i) 33% electricity (of which 90% renewable subsidies, 10% grid investment); (ii) 30% EVs promotion via scrappage scheme; (iii) 30% energy efficiency in buildings; and (iv) 7% energy efficiency in industries. The first two measures are modelled in the technology diffusion sub-models in E3ME12. Despite the short-term nature of stimulus measures, due to technology path dependency, it is expected to have long-lasting impacts on renewables diffusion and take-up of EVs. Energy efficiency is modelled using cost assumptions per unit of energy savings53. As a non-equilibrium and non-optimized model, E3ME’s energy efficiency modelling does not automatically assume crowding out of other investments54. Instead, it can tap into existing spare and additional capacity created during the pandemic to achieve economic stimulus from energy efficiency investment.

The green stimulus as assumed in the **IMAGE** model is split into (i) 32% electricity (of which 80% renewable subsidies, 20% grid investment); (ii) 30% transport via promotion of EV sales and efficient ICEs; (iii) 30% energy efficiency in buildings via promotion of renovation of existing buildings, construction of new efficient buildings, and installation of sustainable appliances and infrastructure (residential PV systems, heat pumps and biomass boilers); and (iv) 8% energy efficiency in the industrial sector by targeting steel and cement production. The slightly higher amount allocated to industry in the IMAGE model is aimed at reducing methane leakages from oil and gas production, which was straightforward to implement in IMAGE. Even measures that incur high costs are a very effective way to reduce GHG emissions, as methane is a very potent greenhouse gas55.

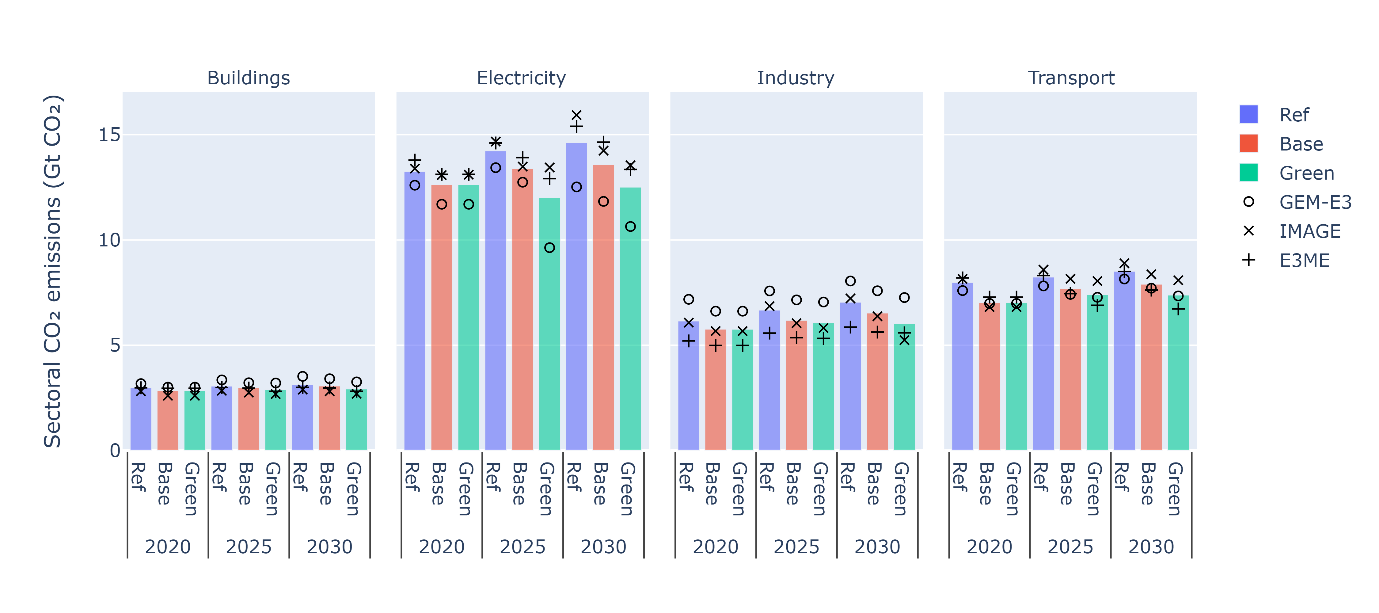
# Supplementary Data 4: Comparison of the results of this study with IEA

Comparing the three models' results to the IEA’s Sustainable Recovery report55, our models show lower reductions by 2025 than IEA’s sustainable recovery plan. More specifically, IEA projects that the Green Recovery scenario will result in 3.5 Gt CO2 reduction, relative to an IEA’s COVID baseline that has no increase in investments by 2025, and 1 Gt CO2 reduction relative to 2020 levels. The E3ME and IMAGE Green Recovery scenarios show a relative decrease of 2 Gt CO2 and 1 Gt CO2 in 2025 compared with the COVID scenario. In contrast, GEM-E3 achieves a higher level of reductions in 2025, at 3.2 Gt CO2. There are different factors that explain the higher reductions by IEA. First, IEA’s COVID baseline projects higher emission growth rates due to rebound effects after 2020 (return to 2019 levels by 2023) than the COVID scenarios of the three models used in this study (return to 2019 levels by 2024-2026), which leads to a higher reduction for IEA. Second, the IEA recovery scenario assumes today’s announced policy intentions and targets56, which goes beyond the current policies, as assumed in this study. Third, IMAGE eventually achieves a reduction similar to IEA’s in 2030 instead of 2025, mainly due to the assumed inertia in the energy system in the model. Fourth, in GEM-E3-FIT and E3ME, a larger CO2 reduction can be expected if the socio-economic impacts of Green Recovery that boost GDP growth and thus increase emissions in the absence of strong climate policies are not considered.

# Supplementary Figures and Tables



Supplementary Figure 1: Global GDP and CO2 emission projections. **a,** Global GDP (expressed in MER US$) between 2019 and 2030 (normalised to the 2019 model levels, taking 2019 levels as 100), for all scenarios, as projected by the three global models. **b,** Global CO2 emission projections from energy and industrial processes between 2019 and 2030, normalised to the 2019 model levels then multiplied with 2019 emission from GCP57, for all scenarios. The 2 °C scenario range shows the global CO2 emissions from energy and industrial processes consistent with a least cost-pathway towards limiting global average temperature increase below 2 °C by 2100 with about 66% probability.



Supplementary Figure 2: Sectoral CO2 emissions. Contribution of each sector to CO2 emissions from energy and industrial processes, for 2020, 2025 and 2030 (x-axis), for all scenarios (colour). Symbols indicate individual model results. The bars indicate model mean and were added for reporting reasons.

Supplementary Table 1:Global GDP growth rates for all scenarios, for all models.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Scenario | 2020 | 2021 | 2022 | 2023-2025  (average) | 2026-2030  (average) |
| *Reference* |  |  |  |  |  |
| IMAGE | 3.7% | 3.4% | 3.5% | 3.6% | 3.1% |
| E3ME | 2.7% | 2.7% | 2.8% | 2.7% | 2.7% |
| GEM-E3-FIT | 3.1% | 3.4% | 3.3% | 3.1% | 2.9% |
| *COVID* |  |  |  |  |  |
| IMAGE | -4.9% | 5.6% | 3.1% | 3.0% | 3.1% |
| E3ME | -4.9% | 5.3% | 2.8% | 2.7% | 2.7% |
| GEM-E3-FIT | -5.0% | 4.6% | 3.9% | 3.5% | 2.9% |
| *Green Recovery* |  |  |  |  |  |
| IMAGE | -4.9% | 6.7%\* | 3.0% | 3.0% | 3.1% |
| E3ME | -4.9% | 6.3% | 2.7% | 2.5% | 2.7% |
| GEM-E3-FIT | -5.0% | 4.9% | 4.3% | 3.6% | 2.9% |

*\** IMAGE used the E3ME GDP data, which shows a similar increase between the COVID and Green Recovery scenario

Supplementary Table 2:Projected changes in GDP and employment for 2025 and 2030 between the COVID and Green Recovery scenarios, as projected by E3ME and GEM-E3-FIT models

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | GEM-E3-FIT | | E3ME | |
|  | 2025 | 2030 | 2025 | 2030 |
| Global GDP | 0.5% | 0.5% | 0.2% | 0.2% |
| Global Employment | 0.4% | 0.4% | 0.0% | 0.0% |
| EU GDP | 1.0% | 0.9% | 0.8% | 0.5% |
| EU Employment | 1.0% | 0.6% | 0.4% | 0.3% |
| China GDP | 0.5% | 0.4% | 0.4% | 0.6% |
| China Employment | 0.4% | 0.3% | 0.0% | 0.0% |
| India GDP | 0.3% | 0.4% | 0.2% | 0.2% |
| India Employment | 0.3% | 1.0% | -0.1% | -0.1% |
| USA GDP | 0.4% | 0.3% | -0.2% | -0.2% |
| USA Employment | 0.4% | 0.2% | 0.0% | 0.0% |

# Supplementary References

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