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Are long-term climate emissions scenarios plausible today? Scientists review using historical emissions data



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Long-term emissions scenarios are a vital tool in evaluating future climate-change and response strategies. This study seeks to assess whether Intergovernmental Panel for Climate Change (IPCC) emission projections, based on these scenarios, are relevant today — by examining historical trends and projections for key variables during 1990–2017.

The purpose of emissions scenarios is to explore possible trajectories of climate change under different scenarios. As the future is uncertain, these scenarios are not predictions, however, they should be plausible regarding current economic structures, demographics and energy systems. In 1990 the IPCC first developed emissions scenarios to clarify how climate change might progress over time. Since then the IPCC has issued further emissions scenarios reports, and developed the Representative Concentration Pathways (RCPs) — a greenhouse gas concentration trajectory which establishes different climate futures — all of which are possible by the end of the century.

The climate-change research community has also developed the Shared Socioeconomic Pathways (SSPs) — a complementary framework to the RCP, based on five possible roads which the world could take in the absence of climate policy. These baseline SSP paths are: rapid growth, middle of the road, regional competition, regional sustainability and global sustainability.

Between 1990 to 2019 [greenhouse gas emissions in Europe decreased by 24%¹ — exceeding the EU's target of a 20% decrease by 2020](#). Furthermore, future projections based on current and planned measures in the EU-27, show a conservative 36% reduction of emissions by 2030. Europe signed up to the Paris Agreement in 2015 and, under the [Green Deal](#), aims to achieve carbon neutrality by 2050.

Due to changes in global circumstances the researchers suggest that long-term developments in key socioeconomic drivers (such as population, GDP, energy system characteristics) and greenhouse gas emissions (such as carbon dioxide (CO₂) from energy and industry) should be compared with long-term IPCC emissions scenarios on a regular basis to ensure they are still plausible.



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Are long-term climate emissions scenarios plausible today? Scientists review using historical emissions data (continued)

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The emissions scenarios often inform the [United Nations Framework Convention on Climate Change](#) (UNFCCC) negotiations and associated national and international climate policies. The researchers suggest that, with almost 30 years of historical data, a longer-term assessment of the scenario sets is possible and warranted.

The researchers investigated the four climate-emissions scenario series² (which informed the five assessment reports of the IPCC), compared with historical trends in CO₂ emissions and socioeconomic developments. The researchers established historical trends of CO₂ emissions from fossil fuel combustion and industry datasets, then analysed these in relation to sources or drivers of emissions from 1960 to 2017.

The researchers used key variables, common to all of the scenarios: CO₂ from fossil fuel and industry, population, GDP, and energy system characteristics. This analysis was then compared to the assumptions underlying the scenarios. Historical trends for the period 1990 to 2017 (CO₂ emissions and drivers) for all variables, were then used to compare growth rates with the four IPCC emission scenario series — to update various projected futures.

The results of the statistical analysis of historical trends showed that the IPCC scenarios did not systematically over- or underestimate historical global emissions. Instead global emissions were found to follow a medium-high emissions pathway, well within scenario ranges. This shows that the scenarios are still valid to use in past and future analyses of climate change and impacts. The researchers found that CO₂ emissions were tightly linked with primary energy and indirectly connected with GDP.

The scenarios tended to overestimate the CO₂ emissions and GDP growth from the 37 member countries of the Organisation for Economic Co-operation and Development (OECD), (with high economic development); whilst underestimating non-OECD countries, notably China and India. Adjusting the Shared Socioeconomic Pathways baselines for ‘non-biomass renewables’ and ‘nuclear’ may be considered for future updates as these are areas where the emissions scenarios captured the historical trends less effectively.

The research found that there were six overall periods of fast/slow CO₂ growth (from 1960 to 2020), which highlights the importance of long- as well as short-term evaluations.

This study informs policymakers on the validity of emissions scenarios for use in planning future climate-change response strategies. Rapid growth narratives in non-OECD countries matches with the historical data, which may have important implications for future greenhouse gas emissions and associated climatic change. In addition, adjusting the SSP-scenario baselines for nuclear and non-biomass renewables such as wind and solar could lead to a more accurate projection for future climate analysis.

1. European Environment Agency (2020). Indicator assessment: *Total greenhouse gas emission trends and projections in Europe*. Available from: <https://www.eea.europa.eu/data-and-maps/indicators/greenhouse-gas-emission-trends-7/assessment> [Accessed 17/03/2021].

2. IPCC (1990) *Scientific Assessment Report (SA90)*; IPCC (1992) *Scenarios Report (IS92)*; IPCC (2000) *Special Report: Emissions Scenarios (SRES)*, and Representative Concentration Pathways / Shared Socioeconomic Pathways which informed the five assessment reports of the IPCC and the sixth assessment cycle.