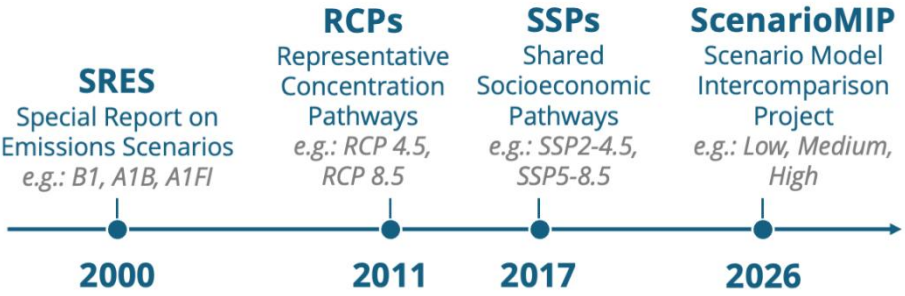
Primer on Greenhouse Gas Scenarios

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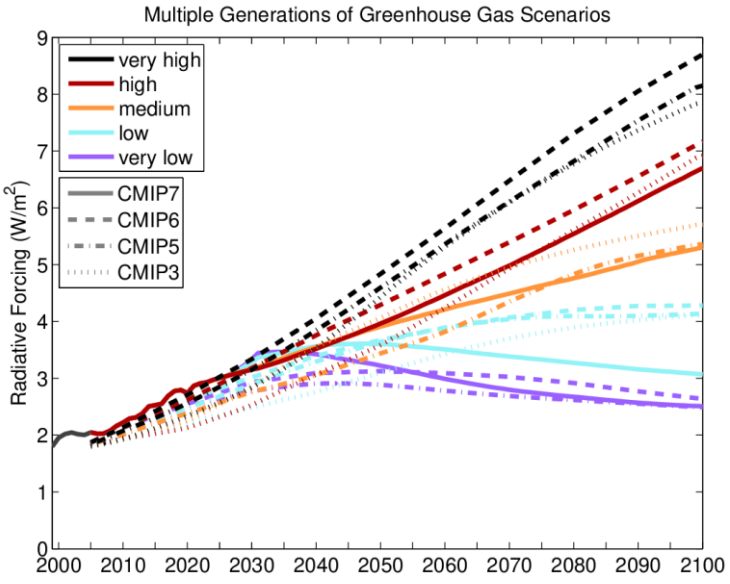
What is a "Greenhouse Gas Scenario"?

Greenhouse gas scenarios are "what if" scenarios of future greenhouse gas emissions that are used as input to global climate model (GCM) simulations to estimate future changes in climate. They are developed based on assessments of potential changes in global population, geopolitics, economic development, energy system changes, and other factors. Greenhouse gas scenarios are typically developed using Integrated Assessment Models (IAMs) that translate socioeconomic conditions to concentrations of greenhouse gases. Greenhouse gas concentrations can then be used to calculate "radiative forcing," or the increase in net energy due to the atmospheric greenhouse effect.

How have scenarios changed over time?



With each new assessment report by the Intergovernmental Panel on Climate Change (IPCC), a new set of Global Climate Model (GCM) projections are developed that incorporate updates in both the greenhouse gas scenarios used as input to the models and improvements to the models themselves. GCM projections are coordinated under Coupled Model Intercomparison Projects (CMIP), numbered sequentially (e.g. CMIP6). The last set of scenarios, ScenarioMIP-CMIP7, will be used in the upcoming IPCC report, due for release in 2029.



The graph shows that there are similarities between earlier and newer generations of greenhouse gas scenarios – scenarios are color-coded based on

their radiative forcing in 2100 (for clarity, the plot shows a representative subset of all available scenarios). One exception is the highest scenarios, in black; those high-end scenarios have been discontinued in ScenarioMIP-CMIP7.

What can we say about the likelihood of different scenarios?

High-end scenario: In previous generations of scenarios, the high-end scenario (SSP5-85, RCP 8.5, SRES A1FI) assumed that emissions of greenhouse gases increase substantially until the end of the 21st century, and atmospheric CO2 concentrations more than triple by 2100 relative to pre-industrial levels. Recent research finds that these high-end scenarios have become implausible, largely due to a combination of current climate policies and changes in the cost of renewable energy (e.g. Hausfather et al. 2025). As a result, this high-end scenario is omitted from the newest generation of scenarios (ScenarioMIP-CMIP7).

Low-end scenarios: Consistent with previous generations, the new scenarios include several aggressive mitigation scenarios ("Low", "Very-Low", "Low-to-Negative"), where emissions are rapidly reduced to keep warming below 2°C by 2100 (though some include potential overshoot). All these scenarios require rapid reductions and even net negative emissions by 2100. For example, the least aggressive "Low" scenario would require about a 50% reduction in global emissions by 2050 relative to today's levels, and net negative emissions starting around 2070. Achieving such rapid reductions would be challenging and, in some cases, may not be feasible (e.g. IPCC 2026).

Warming beyond 2100: Warming beyond 2100 could still reach the levels of previous high-end scenarios. For example, the new "High" scenario reaches a radiative forcing of 8.5 W/m² by about 2150 (this is the level reached by RCP 8.5 and SSP5-8.5 in 2100), and peaks at about 10 W/m² after 2200.

What does this mean for decision-making?

Both the low- and high-end scenarios in previous generations are unlikely to manifest during this century. Yet many existing impacts studies are based on the high-end RCP 8.5 or SSP5-8.5 scenarios. Such studies can still be used, but some additional interpretation is needed. Here are a few important points to keep in mind:

- The choice of scenario is much less important for changes before about 2050.
- In many scenarios, warming continues beyond 2100.
- One option can be to translate time for emissions (for example, 2040s projections for RCP 8.5 are similar to the 2080s projections for RCP 4.5). *Note:* This only works for changes that have a relatively short response time to warming (e.g. temperature, snowpack).
- Choosing a high-end scenario can be a way to hedge against other uncertainties. For example, high-end GCM projections for medium and high scenarios can overlap significantly with GCM projections for the RCP 8.5 or SSP5-8.5 scenarios.

As always, choosing which projection to plan for is a policy decision that depends on the gravity of the risk and the trade-offs among adaptation options.