

Climate Benefits of a Rapid Global HFC Phase-Out (Executive Summary)

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Background/Objective/Methodology

With the adoption of the Kigali Amendment to the Montreal Protocol in 2016, an essential milestone for climate protection was reached. The Kigali Amendment sets out a legally binding multilateral agreement to govern the production and consumption of hydrofluorocarbons (HFCs) and will hence provide a major boost to the prospects for climate-friendly refrigerants and accelerate innovation for sustainable technologies. This latest amendment to the Montreal Protocol will considerably contribute to the long-term goals of the Paris Agreement to hold the global temperature rise to well below 2° Celsius above pre-industrial levels and to pursue efforts to limit the increase in temperature to 1° Celsius. In addition to the global regulation, there is regulatory action at regional and national level to control HFCs.

Velders (2016) indicate that a successful implementation of the Kigali Agreement is meant to stall global warming from HFC emissions to 0.06° Celsius. In contrast, without any reduction measures, HFC emissions could cause a global temperature increase up to 0.35 to 0.5° Celsius (Velders et al. 2015, Xu et al. 2013). Hence, the implementation of the Kigali Amendment is considered to contribute to overall greenhouse gas reduction targets, thus providing a crucial opportunity to meet the Paris Agreement's long-term goals.

However, opinions diverge whether or not the agreed Kigali Agreement is ambitious enough. It is assumed that accelerating the HFC phase-down schedules would only have a limited impact. In contrast, a complete global HFC phase-out in the near future could have a significant effect. As there is urgent need for accelerated short-term action, it should be borne in mind that the Montreal Protocol contains a specific provision, which provides an important opportunity to increase ambition over time: Article 2, paragraph 9 allows for quickly adopting future adjustments and thus accelerating existing agreements.

Estimates on climate benefits of HFC phase-down and phase-out scenarios generally depend on a broad range of factors and assumptions. We established a model based on the consumption of HFCs and HCFCs/CFCs and their respective CO₂e quantities, in order to assess the climate benefits of the following scenarios:

- Global HFC phase-down according to the Kigali Amendment
- Global HFC phase-out by 2020, 2025 and 2030

The modelling tool allows analysing and assessing the respective climate benefits (expressed in CO₂e). The assessment of the potential contribution of a total global HFC phase-out to limit global temperature increase requires the projection of HFC consumption until the end of this century, i.e. 2100. All results thus refer to the time period from 2015 to 2100.

Climate benefits of the Kigali Amendment

According to our calculations, the combined HFC consumption of developed (A2) and developing (A5) countries would continue to increase and could reach 5.3 Gt CO₂e in 2050 and 12.5 Gt CO₂e in 2100, without the implementation of the Kigali Amendment (BAU). In many A2 countries, national and regional actions have already been introduced. However, HFC BAU consumption would further increase to about 1.5 Gt CO₂e in 2100, in case the Kigali Amendment would not come into force, adding up to a cumulative climate effect of about 71 Gt CO₂e. Unlimited HFC growth in A5 countries would have an enormous climate impact, reaching about 11 Gt CO₂e in 2100 and a cumulative climate effect of 481 Gt CO₂e until the end of this century. The climate effect in A5 countries is considerably larger. Overall, a successful implementation of the Kigali Amendment could result in a cumulative climate benefit of about 58 Gt CO₂e by 2050 and about 484 Gt CO₂e by 2100, leaving a remaining HFC quantity (tail consumption) of about 68 Gt CO₂e.

Climate benefits of a global HFC phase-out

Results for three different global HFC phase-out scenarios are presented in the following. Until the respective HFC phase-out takes effect, it is assumed that the adopted HFC phase-down schedules apply.

Compared to the HFC phase-down to be implemented by the Kigali Amendment, a **total global HFC phase-out**, i.e. a phasing out of HFCs without any transitional provisions, would further reduce HFC consumption as displayed in the following figures and the summary table below. A total global HFC phase-out will have an increasing impact on CO₂e reduction, the earlier it is implemented.

Figures: Climate benefits of a total global HFC phase-out by 2020, 2025, 2030

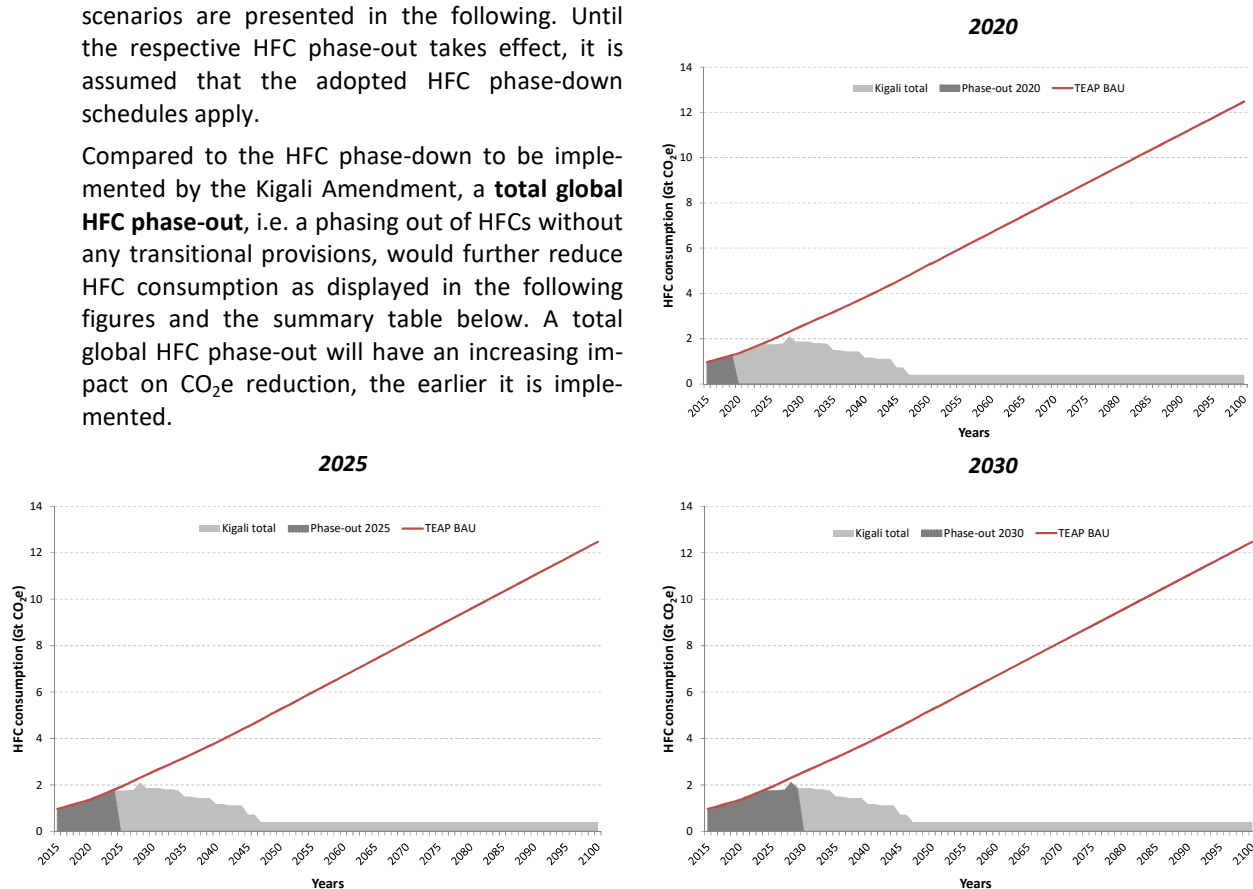


Table 1: Projected impact of the HFC phase-down and HFC phase-out scenarios from 2015 to 2100

	Kigali HFC phase-down	HFC phase-out 2030	HFC phase-out 2025	HFC phase-out 2020
Reduction compared to TEAP BAU	484 Gt CO ₂ e	529 Gt CO ₂ e	539 Gt CO ₂ e	546 Gt CO ₂ e
Reduction compared to Kigali HFC phase-down		45 Gt CO ₂ e	55 Gt CO ₂ e	62 Gt CO ₂ e
Remaining HFC consumption	68 Gt CO ₂ e	23 Gt CO ₂ e	13 Gt CO ₂ e	6 Gt CO ₂ e

Conclusions: Avoided temperature increase

Xu et al. (2013) stated that the replacement of all HFCs with low-GWP substitutes could avoid warming of as much as 0.35 to 0.5° Celsius by 2100. According to our calculations, the Kigali Amendment will result in a limitation of global temperature rise, avoiding 0.31 to 0.44° Celsius by 2100. This would imply that, since the Kigali Amendment will implement a HFC phase-down, the remaining HFC quantities will likely still cause warming of up to 0.06° Celsius by 2100, and is in line with results from Velders (2016). With regard to a global phase-out, the largest climate benefit results from the implementation of a HFC phase-out in 2020. In this case, the climate benefit could be further increased by 0.05° Celsius compared to the Kigali Amendment and strengthen international efforts to reach the long-term goals of the Paris Agreement.

Table 2: Climate benefit (avoided temperature increase) of the HFC phase-down and HFC phase-out scenarios on global warming by 2100

	Kigali HFC phase-down	HFC phase-out 2030	HFC phase-out 2025	HFC phase-out 2020
Climate benefit by 2100	0.31 - 0.44° C	0.34 - 0.48° C	0.34 - 0.49° C	0.35 - 0.49° C