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## Significance of long-term climate evolution and associated impacts on the long-term safety of a high-level radioactive waste repository within the German siting process

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According to the 'Act on the Organizational Restructuring in the Field of Radioactive Waste Disposal' the BGE was established in 2016. The amended 'Repository Site Selection Act' (StandAG) came into force in July 2017 and forms the base for the site selection by clearly defining the procedure. According to the StandAG the BGE implements the participative, science-based, transparent, self-questioning and learning procedure with the overarching aim to identify the site for a high-level radioactive waste (HLW) repository in a deep geological formation with best possible safety conditions for a period of one million years.

The German site selection procedure consists of three phases, of which Phase 1 is divided into two steps. Starting with a blank map of Germany, the BGE completed Step 1 in September 2020 and identified 90 individual sub-areas that provide favorable geological conditions for the safe disposal of HLW in the legally considered host rocks; rock salt, clay and crystalline rock. Based on the results of Step 1, the on-going Step 2 will narrow down these sub-areas to siting regions for surface exploration within Phase 2 (§ 14 StandAG). Central to the siting process are representative (Phase 1), evolved (Phase 2) and comprehensive (Phase 3) preliminary safety assessments according to § 27 StandAG.

The ordinances on 'Safety Requirements' and 'Preliminary Safety Assessments' for the disposal of high-level radioactive waste from October 2020 regulate the implementation of the preliminary safety assessments within the different phases of the siting process. Section 2 of the 'Safety Requirements' ordinance provides requirements to evaluate the long-term safety of the repository system; amongst others, it states that all potential effects that may affect the long-term safety of the repository system need to be systematically identified, described and evaluated as "expected" or "divergent" evolutions. Additionally, the ordinance on 'Preliminary Safety Assessments' states in § 7, amongst others, that the geoscientific long-term prediction is a tool to identify and to evaluate geogenic processes and to infer "expected" and "divergent" evolutions from those. Hence, considering the time period of one million years for the safe disposal of the HLW and the legal requirements, it is essential to include long-term climate evolution in the German site selection process to evaluate the impact of various climate-related scenarios on the safety of the whole repository system.

To better understand and evaluate the influence of climate-related processes on the long-term safety of a HLW repository, climate-related research will be a part of the BGE research agenda. Potential research needs may address i) processes occurring on glacial – interglacial timescales (e.g. the inception of the next glaciation, formation and depth of permafrost, glacial troughs, sub-glacial channels, sea-level rise, orbital forcing) and their future evolutions, ii) effects on the host rocks and the barrier system(s) as well as iii) the uncertainties related to these effects but also to general climate models and predictions.