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The potential impact of hydrogen energy use on the atmosphere

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Energy models show very different trajectories for future energy systems (partly as function of future climate policy). One possible option is a transition towards a hydrogen-based energy system. The potential impact of such hydrogen economy on atmospheric emissions is highly uncertain. On the one hand, application of hydrogen in clean fuel cells reduces emissions of local air pollutants, like SOx and NOx. On the other hand, emissions of hydrogen from system leakages are expected to change the atmospheric concentrations and behaviour (see also Price et al., 2007; Sanderson et al., 2003; Schultz et al., 2003; Tromp et al., 2003). The uncertainty arises from several sources: the expected use of hydrogen, the intensity of leakages and emissions, and the atmospheric chemical behaviour of hydrogen.

Existing studies to the potential impacts of a hydrogen economy on the atmosphere mostly use hydrogen emission scenarios that are based on simple assumptions. This research combines two different modelling efforts to explore the range of impacts of hydrogen on atmospheric chemistry. First, the potential role of hydrogen in the global energy system and the related emissions of hydrogen and other air pollutants are derived from the global energy system simulation model TIMER (van Vuuren, 2007). A set of dedicated scenarios on hydrogen technology development explores the most pessimistic and optimistic cases for hydrogen deployment (van Ruijven et al., 2008; van Ruijven et al., 2007). These scenarios are combined with different assumptions on hydrogen emission factors. Second, the emissions from the TIMER model are linked to the NCAR atmospheric model (Lamarque et al., 2005; Lamarque et al., 2008), in order to determine the impacts on atmospheric chemistry. By combining an energy system model and an atmospheric model, we are able to consistently explore the boundaries of both hydrogen use, emissions and impacts on atmospheric chemistry.

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