



## **Social tipping elements instrumental for decarbonization by 2050**

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If the Sustainable Development Goals and the Paris Climate Agreement are taken seriously, a global sustainability transition could be achieved in the next 30 years. The central prerequisite for such a global sustainability transition is the complete decarbonization of our energy sector. We ask what are the social leverages that could lead to the emergence of the fossil-fuel-free economy. While many researchers are focusing on incremental changes and the gradual phasing out of coal, we explored cross-scale and multi-actor social leverages that can lead to a rapid and deep decarbonization. We use the term social tipping element to describe a subsystem that is relevant for the dynamics of the whole socio-economic system and that is susceptible to small changes or innovations that have the potential to tip the whole system into a qualitatively different state. This could happen through triggering large-scale processes or through microscopic interventions having domino effects and causing macroscopic changes. Our understanding of the "social" component of the system is very broad and could refer to people's values and behaviors, social institutions, economic activities and political mechanisms as well as to technologies that could substantially change the social-ecological relationships. The empirical material is based on an expert elicitation. The analyzed examples of social tipping elements include social value changes, policies such as shutting down coal power plants and abandoning industrial agriculture. In the socio-economic realm, we show documented instances of technology and business solutions exhibiting that 17-18% market share is sufficient to tip the scales and become the dominant pattern. We discuss the relevance and certainty associated to each of our social tipping elements and lay out the geographic and time scales for leveraging those elements.