



## **Low frequency variability of Climate-Related-Energy penetration in Europe**

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The penetration rate of Climate Related Energy sources like solar-power, wind-power and hydro-power source measures the mismatch between the energy availability from those fatal productions and the energy demand which may be also partly dependent on the climate. The penetration rate is a key factor – with potentially large technical and economic implications, to be accounted for in public policies and private initiatives for a massive integration of renewables in the classical energy system. For a given region, it is classically estimated from high resolution time series of energy productions and energy demand derived from times series of their driving climatic variables (temperature, wind, radiation, precipitation).

The penetration rate obviously highly depends on the seasonal and also high frequency time variability of these climatic variables (François et al. 2016). A less studied aspect of this penetration rate is its dependence to low frequency variability of climate, from annual to pluriannual time scales. We here explore this dependence for a set of 12 contrasted hydroclimatic regions in Europe with long time series of weather variables reconstructed for the whole 20th century. We discuss the interannual, and interdecadal variability of the penetration rate for the solar-power, wind-power and run-of-the river energy sources taken individually and for different mixes. We discuss how it can be increased / stabilized with local energy storage.

Reference : François, B., Hingray, B., Raynaud, R., Borga, M. and Creutin, J.D., 2016. Increasing Climate-Related-Energy penetration by integrating run-of-the river hydropower to wind/solar mix. *Renewable Energy*, 87(1), pp.686–696. doi:10.1016/j.renene.2015.10.064

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