

# **Deployment of Renewable Energy Sources: Empirical Evidence in Identifying Clusters with Dynamic Time Warping**

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Deployment of renewable energy sources has caused a seismic shift in the world energy arena. Individual and coordinated efforts across countries and regions are shaping the world for the future, including business models which are supported globally to achieve net zero goals by 2050. This has resulted in changing cost structures, prices, and investment in energy uses, and approaching towards most sustainable environments for most of the regions. Our aim in this paper is to identify clusters of countries, where within a particular cluster, the levels of deployment of renewable energy sources are similar while across clusters, they are different. We propose a time series clustering method capturing the time-varying features of the renewable energy time series of 130 countries to enable the assessment of how similar or how different the usage is in relation to the Organisation for Economic Co-operation and Development (OECD) status of countries, their regional location, and their income grouping. Using Dynamic Time Warping (DTW) which is a method that calculates an optimal match between two given time series with certain restrictions, we the adopt the Partitioning Around Medoids (PAM) technique in a fuzzy framework to obtain cluster solutions. Our analysis shows that both 4-cluster and 5-cluster solutions best capture country separation based on OECD status, regional location, and income grouping.

## **Keywords**

Renewable energy; Dynamic time warping; Partitioning around medoids; Fuzzy clustering.