



Wind and solar energy resources on the ‘Roof of the World’

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The Eastern Pamirs of Tajikistan, often referred to as ‘Roof of the World’, are an arid high mountain plateau characterized by severe energy poverty that may have great potential for renewable energy resources due to the prevailing natural conditions. The lack of energetic infrastructure makes the region a prime target for decentralized integration of wind and solar power. However, up to date no scientific attempt to assess the regional potential of these resources has been carried out.

In this context, it is particularly important to evaluate if wind and solar energy are able to provide enough power to generate thermal energy, as other thermal energy carriers are scarce or unavailable and the existing alternative, local harvest of dwarf shrubs, is unsustainable due to the slow regeneration in this environment. Therefore, this study examines the feasibility of using wind and solar energy as thermal energy sources. Financial frame conditions were set on a maximum amount of five million Euros. This sum provides a realistic scenario as it is based on the current budget of the KfW development bank to finance the modernization of the local hydropower plant in the regions only city, Murghab, with about 1500 households.

The basis for resource assessment is data of four climate stations, erected for this purpose in 2012, where wind speed, wind direction, global radiation and temperature are measured at a half hourly interval. These measurements confirm the expectation of a large photovoltaic potential and high panel efficiency with up to 84 percent of extraterrestrial radiation reaching the surface and only 16 hours of temperatures above 25°C were measured in two years at the village stations on average. As these observations are only point measurements, radiation data and the ASTER GDEM was used to train a GIS based solar radiation model to spatially extrapolate incoming radiation. With mean validation sufficient errors ranging from 5% in July (minimum) to 15% in December (maximum) the extrapolation showed sufficient modeling performance to create the first solar atlas of the Eastern Pamirs. This solar atlas, adapted to optimal panel inclination using 5000 random points, was used to compute expected electricity amounts for two scenarios: one for decentralized small scale implementation and one for a larger scale photovoltaic (PV) power plant. Based on the month with the minimum incoming radiation and the expected energy demand for cooking, the cost for the required infrastructure was assessed. The results showed that an implementation of a PV power plant in Murghab would generate enough power for basic cooking within the estimated budget in winter. In summer the power plant would deliver at least as much energy as the planned hydropower plant if latter would continuously deliver its anticipated peak power. The decentralized scenario for a village with 210 households without existing energy grid resulted in higher investment costs of about 8,000 € per household to meet basic cooking demands in winter. Wind energy potential was assessed based on local wind measurements and an assumed installation of small scale wind turbines. Short time scale comparison of wind and solar resources showed that they mainly occur simultaneously and positive synergy effects are negligible. Furthermore, the financial analysis resulted in significantly higher cost for wind energy even in favorable locations making this resource less important for the region.

Our results suggest that solar energy could make a substantial contribution to sustainable energy supply and to alleviate energy poverty and environmental degradation in the Eastern Pamirs of Tajikistan.