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A Feasibility and Implementation Model of Small-Scale Hydropower Development for Rural Electrification in South Africa: Design Chart Development

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Abstract : Small scale hydropower used to play a very important role in the provision of energy to urban and rural areas of South Africa. The national electricity grid, however, expanded and offered cheap, coal generated electricity and a large number of hydropower systems were decommissioned. Unfortunately, large numbers of households and communities will not be connected to the national electricity grid for the foreseeable future due to high cost of transmission and distribution systems to remote communities due to the relatively low electricity demand within rural communities and the allocation of current expenditure on upgrading and constructing of new coal fired power stations. This necessitates the development of feasible alternative power generation technologies. A feasibility and implementation model was developed to assist in designing and financially evaluating small-scale hydropower (SSHP) plants. Several sites were identified using the model. The SSHP plants were designed for the selected sites and the designs for the different selected sites were priced using pricing models (civil, mechanical and electrical aspects). Following feasibility studies done on the designed and priced SSHP plants, a feasibility analysis was done and a design chart developed for future similar potential SSHP plant projects. The methodology followed in conducting the feasibility analysis for other potential sites consisted of developing cost and income/saving formulae, developing net present value (NPV) formulae, Capital Cost Comparison Ratio (CCCR) and levelised cost formulae for SSHP projects for the different types of plant installations. It included setting up a model for the development of a design chart for a SSHP, calculating the NPV, CCCR and levelised cost for the different scenarios within the model by varying different parameters within the developed formulae, setting up the design chart for the different scenarios within the model and analyzing and interpreting results. From the interpretation of the develop design charts for feasible SSHP in can be seen that turbine and distribution line cost are the major influences on the cost and feasibility of SSHP. High head, short transmission line and islanded mini-grid SSHP installations are the most feasible and that the levelised cost of SSHP is high for low power generation sites. The main conclusion from the study is that the levelised cost of SSHP projects indicate that the cost of SSHP for low energy generation is high compared to the levelised cost of grid connected electricity supply; however, the remoteness of SSHP for rural electrification and the cost of infrastructure to connect remote rural communities to the local or national electricity grid provides a low CCCR and renders SSHP for rural electrification feasible on this basis.

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