Data Article

Techno-economic data for decentralised energy system sizing for rural areas in Benin. A case study of the village of Fouay

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ABSTRACT

This data article is related to the research article “O.D.T. Odou, R. Bhandari, R. Adamou, Hybrid off-grid renewable power system for sustainable rural electrification in Benin, Renew. Energy. 145 (2020) 1266—1279. doi:10.1016/j.renene.2019.06.032.”. The data presented are grouped into four (04) groups as follows: Load, Resources, Components costs and specification and Optimization and Simulation data. The data are mainly acquired from onsite survey for the load demand, National Direction of Water (DGeau) for rivers streamflow, National Direction of Meteorology (DNM) for meteorological data, expert knowledge and HOMER software model output data. An empirical method is used to estimate the river streamflow at Fouay from the known gauged streamflow data. The purpose of this article is to make available reliable open access data to allow replicability and enhance research in similar studies while giving first-hand information to users.

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The data in this article is dealing with a design of an energy system to power in sustainable manner rural area with sources that environmentally friendly.

Subject: Energy
Specific subject area: The data in this article is dealing with a design of an energy system to power in sustainable manner rural area with sources that environmentally friendly.

Type of data: Table, Image, Figure

How data were acquired:
- Onsite Survey (paper-based) in the village of Fouay
- Streamflow data from the National Direction of Water (DGeau)
- Weather data from the National Direction of Meteorology (DNM)
- Processed Model data from the HOMER software simulation output

Data format: Raw, Analyzed, Filtered, Processed

Parameters for data collection:
The survey sample was comprised of 50 households selected randomly; six business owners and all the community socio-services.
The meteorological data are daily data from 2000-2016.
Rivers Streamflow data are daily data with about 53 years data at least were obtained.
Equipment costs are prices from the local market which captures better the Benin republic context.
The simulation output data are from the HOMER Software on its version 3.9.2.

Description of data collection:
Regarding the survey, it was a paper-based one administrated to households, business owners and social services institution in the village. Prior, the survey, official authorization paper from the local administration and research institution were obtained to facilitate the work on the ground with the local community. The data is thereafter entered in an excel table to generate the load profile. The meteorological and streamflow data were already in a good format to be pasted in an excel sheet and rearranged. These data were acquired based on the request sent to the DNM and DGeau while specifying the parameter and the timescale wanted.

Data source location:
Survey data
City/Town/Region: Fouay/Kandi/Alibori
Country: Benin Republic
Latitude and longitude (and GPS coordinates) samples/data): 11.3°N and 3.17°E
Meteorological data
Institution: National Direction of Meteorology (DNM)
City/Region: Cotonou/Littoral
Country: Benin Republic
Latitude and longitude (Station coordinates): 11°08′N/02°56′E
Rivers streamflow data
Institution: National Direction of Water (DGeau)
City/Region: Cotonou/Littoral
Country: Benin Republic

Data accessibility:
The data with this article is available in a public repository of Mendeley Database.
Repository name: Mendeley
Data identification number: 10.17632
Direct URL to data: https://doi.org/10.17632/rcrgv63wnx.1

Related research article:
Author’s name: Oluwarotimi Delano Thierry Odou
Title: Hybrid off-grid renewable power system for sustainable rural electrification in Benin
Journal: Renewable Energy
DOI: https://doi.org/10.1016/j.renene.2019.06.032.

Value of the Data:
- This data gives a standard load profile of a rural community in Benin which may be adjusted or used as typical load profile by other research.
- This data contains large river streamflow data of two-gauge stations from 1953-2012 in Northern Benin and can be an input for hydrological modelling to evaluate the hydropower production.
- The data (namely: the load profile data, weather data and components costs) can serve as input for renewable energy system sizing in Benin or similar environment.
- This data is useful to assess the electrical production performances of PV/Diesel Generator/Battery configurations system under different seasonal conditions in a year.
- For different values of sensitivity variables, the data helps identify the cost-effective and reliable configuration system. This can be used by other researchers or serve as a first hand of information for decision-making in renewable energy development project.
1. Data

The data of this data article are from the modelling of a Hybrid Energy System for the rural electrification focusing on the village of Fouay in Benin [1]. The data are grouped into 4 categories spread in different worksheets as follow:

1. Resource assessment

The resource assessment comprises the files 1.1.Met_data.xlsx and 1.2. Hydro_Ressource_Modelling.xlsx. The excel worksheet Met_data.xlsx contains the weather parameters namely: Solar radiation, Wind speed, precipitation and temperature at Kandi and the estimated monthly streamflow data for the hydro site of “Sosso”. Kandi is the nearest station from the village of Fouay. These parameters are daily data with different time range. The sheet Hydro_Ressource_Modelling.xlsx contains the; streamflow of the hydropower site of “Cascade de Sosso” as well as the two analogues gauged station streamflow used to perform the estimation. The Couberi gauged station is located at the upstream of Sosso and Gbasse gauged station at the downstream.

2. Load assessment

The electrical energy demand of the village of Fouay details is provided in the excel worksheet 2. Load.xlsx. The electrical load of the village is classified into three main categories: Household load, Community load, and Commercial load. Some assumptions have been made for seasonal variation of the load profile. Three main season load variation are defined summer, winter low and winter high. For each category of the load demand and seasonal variation, an excel sheet in the worksheet describes them respectively. A summary load sheet is created and the yearly load as well.

3. Components costs and specifications

The components costs (PV panels, Diesel Generator (DG), Battery, Inverter, Hydro turbine and grid) and specifications are containing in excel worksheet 3. Components_Costs_Specifications.xlsx. The step size capacity of PV ARRAY, Converter and DG are in a separate sheet on the worksheet and as well as hydropower site details information.

4. Optimization and simulation

Under this section three file are generated. The spreadsheet 4.1. HOMER_all_Optimization.xlsx lists all the feasible simulations and the spreadsheet 4.2. HOMER_Categorized_Optimization.xlsx contains the list of feasible systems according to system type. The above spreadsheets are output retrieved data from HOMER software tools. The third file 4.3. Optimisation_Simulation_Output.xlsx is a retrieved and filtered data from HOMER software output. It contains monthly electric production of PV/DG/Battery and the system components electric production over a year to meet the load. The month of August in the winter and November in summer are taken to capture the system behaviour to balance the load.

Lastly, the survey questionnaire used is provided in the file 5. survey.doc.

2. Experimental design, materials, and methods

A description of the data used and methods are provided in Table 1 below.
### Table 1
Data and methods.

| Data               | Parameters                        | Methods/Details                                                                 | Source(s)/Reference(s) |
|--------------------|-----------------------------------|---------------------------------------------------------------------------------|-------------------------|
| **Meteorological** | Temperature                       | Data obtained from the synoptic station of Kandi-DNM                           | National Direction of Meteorology (DNM) |
| Daily Solar Radiation (2000–2016) | Data obtained from the synoptic station of Kandi-DNM | National Direction of Meteorology (DNM) |
| Daily Wind Speed (2000–2016) | Data obtained from the synoptic station of Kandi (Data measured at 10 m height) | National Direction of Meteorology (DNM) |
| Daily Precipitation (1956–2012) | Data obtained from the synoptic station of Kandi | National Direction of Meteorology (DNM) |
| **Streamflow data** | Couberi streamflow (1956–2012) | Data obtained from the synoptic station of Kandi-DGau | National Direction of Water (DGau) |
| Gbasse Streamflow (1953–2006) | Data obtained from the synoptic station of Kandi-DGau | National Direction of Water (DGau) |
| Sosso streamflow | Streamflow is estimated based on empirical method. The method consists of transposing gauged streamflow data from an analogue catchment. The Gbasse gauged station at the downstream and Couberi at the upstream of the site of Sosso are used. The equation of estimation: 

\[ Q_{Xt} = f_n \left( \frac{A_T}{A_A} \right) \times Q_{XA} \]

Where: \( Q_{Xt} \) is flow in the target ungauged catchment of the power plant; \( Q_{XA} \) is corresponding flow in the analogue catchment \( A \); \( A_T \) is catchment area for the power plant site; \( A_A \) is catchment area for the analogue catchment; \( f_n \) is scaling constant or a function. | [2] |
| **Load Assessment** | Load Profiles | The survey sample comprises 50 households selected randomly; six business shops owners were interviewed and including all the village community socio-services (health centre, worship places, and school). In addition, potential future community and commercial load were added based on the high interest expressed by individuals during the survey. The village load demand is classified into three main categories: Household load, Community load, and Commercial load. The demand varies from one period to another depending on the usage of particular appliances and loads. Three set of seasonal loads are derived: summer, winter low and winter high. The sample household load is used to derive the village total household demand using the cross-product method based on the ratio sample size to population. With an initial assumption that the sample size represents and describes well the population. | On-site survey data |
| **Components Costs and Performances** | PV panels | Prices collected from local Benin market suppliers | [3] |
| Inverter | Prices collected from local Benin market suppliers | [3] |
| Battery | Costs are obtained from the literature review | [5–7] |
| Hydropower | Prices collected from local Benin market suppliers that are being interpolated | [3] |
| Diesel Generator | Local expert knowledge and literature review | [5,8] |
| Grid Optimization and Simulation | Optimization and Simulation | The resources assessment data, load profiles and components cost and specifications were used as input data in HOMER software to perform the optimization, simulation and sensitivity analysis. | HOMER Software Output |
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Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.dib.2019.104501.

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