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Data Article

Data in experimental stand-alone microgrid: Solar production, domestic loads, battery storage and meteorological series

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A R T I C L E I N F O

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A B S T R A C T

At the centre of Reunion Island, a region denoted « Mafate » is non-connected to the main electrical grid. In the context of the “Micro Reseau Mafate” research project, financed by the European Regional Development Fund, the PIMENT Laboratory and the local electrification union SIDELEC aim to develop microgrid stations in this isolated area. More than 300 homes are concerned by this alternative solution that these microgrids represent.
Presented data come from an experimental microgrid between 3 homes at the place called « Roche Plate », where electrical production is obtained by photovoltaic panels and storage by batteries. Local data are collected to simulate electrical systems and determine the optimal working point of energy distribution. These data concern the meteorological conditions, the electrical performance of devices and the inhabitants’ usage of appliances. A weather station placed on the solar plant gives the meteorological conditions of this enclave region. Daily loads for the three families are measured and all the data are stored for analysis. A continuous period of one year of measurements is available for the community and is shared throughout this data paper. These datasets will be completed later. Electrical and meteorological data

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are collected in situ and stored in a central computer server located at the university.

Specifications Table

Subject	Renewable Energy, Sustainability and the Environment
Specific subject area	The optimisation of microgrids powered by photovoltaic technology is reached using storage. Measurements from production to consumption enable us to design configurations.
Type of data	Table (.csv)
How the data were acquired	Solar irradiance, ambient temperature and humidity, pressure, under panel temperature and wind conditions are measured on the roof of the solar plant (Fig. 5). Measurements are collected by the data logger. For microgrid data, all the operating parameters are recorded by the inverter/charger device. The plugin devices allow us to carry out the electrical sub-metering on each house for home consumption recordings. All data are then stored in the Reunion University server via communication gateway and GPRS transfer network.
Data format	Raw
Description of data collection	For meteorological data, the sampling time period is 20s length. Submetering data are collected from the 3 homes. The sampling rate is of 1-minute intervals for consumption and production recordings. A Datalogger communicates with sensors and records all the data from the peripherals. Collecting period: from the 1st of May 2020 to the 1st of May 2021. Due to the facility's remoteness, all meters were transported by helicopter. 8-hour round trips to the site to ensure maintenance work.
Data source location	"Roche Plate", Cirque de Mafate Saint-Paul 97460, Reunion Island, France. Latitude and longitude for collected samples: -21.06959, 55.40631
Data accessibility	Repository name: Zenodo Data identification number: 10.5281/zenodo.8186303 Direct URL to data: https://doi.org/10.5281/zenodo.8186303

1. Value of the Data

The repository contains recordings of the meteorological data, photovoltaic production, battery current and loads of electrical appliances of the 3 homes. These results have value because:

- Data are from the first meteo-station which has been installed at "Roche Plate". These weather data are used to define solar resources for designing the other microgrids currently in progress in Mafate. These data can also be used to develop forecast models of solar resources for tropical climates.
- The data are related to the measurements of the physical parameters of the microgrid in operation. Data are at a fine scale and can be useful to validate models of various operating systems involved in a microgrid: photovoltaic panels, battery cells, an inverter, a controller, etc…
- The dataset is related to real-life usage of electricity by users. A fine and detailed analysis of the following can be done with it: appliance usage habits, seasonal and social behaviours of the users.
- The dataset can be used to model consumption cut-off or deletion when solar production is not enough to provide electricity for all the users. The Energy Management System or

monitoring tools can be developed via an Application Programming Interface tool with real-time data.

2. Objective

The aim of generating this dataset is to deliver open and accessible measures of meteorological and physical data of a microgrid in operation. These data are collected in the scope of the « Micro Reseau Mafate » project. This project develops microgrid installation in an isolated and non-connected area, usually at more than 1000 m altitude [1].

Meteorological data represent a significant input to design a microgrid in this specific configuration [2]. As electricity is produced, stored and dispatched in a local grid, this electricity must be stored or consumed when photovoltaic panels produce in order to use all the solar resources available. As the resource is low in these landlocked regions, the afternoons are often characterized by an overcast sky, battery saturation must be avoided during a sunny sky and low electrical consumption. One of the adjustment variables is the management of consumption using optimal time slots to use electricity. Mathematical models are developed to suggest to the users when it is better to consume energy. Indicators are set up using electrical parameters observed by these data. Efficient management is pursued through effective electric systems from photovoltaic production to consumption. It is obtained through a dedicated tool called the Energy Management System (EMS) [3,4].

3. Data Description

Open source datasets from the experimental research at “Roche plate” are shared with the community: ‘Meteo_dataset’ file, ‘Solar_plant_dataset’ file and ‘Demand_house_dataset’ files. For this latter, each house has a CSV file in the repository identified by its number. They are provided in CSV format. The starting date is the 1st of May 2020 at 00:00:00 and the finishing date is the 1st of May 2021 at 23:59:00. The first file is related to the meteorological data, the second one to the physical parameters from the production unit and the last one to the home loads sometimes by a cluster of electrical appliances (Figs. 1 and 2).

Meteorological data are important to qualify the resources. Solar irradiance, air temperature, ambient humidity, wind speed and wind direction in situ are measured to identify meteorological conditions (see Table 1). All physical parameters from the solar plant are recorded as well: output power and voltage from the solar regulators, output current and voltage from the battery and its operational temperature too (see Table 2). Classical electrical consumption stations in dwellings are a TV set, a freezer, a fridge, a washing machine, radio stations, light bulbs, cell chargers, game consoles and sockets for other appliances. Sometimes appliances are monitored together by cluster (see Table 3). Thanks to smart meters technology, real-time measurements

Table 1
Variables of the “Meteo_dataset” file.

Variable	ID	Designation	Unit
G_{incl}	1	Global solar irradiation (inclined surface at 21° oriented North)	kW/m²
GHI	2	Global solar irradiation on a horizontal surface	kW/m²
T_{pv}	3	The surface temperature under the roof-mounted PV panels	°C
T_a	4	Air temperature	°C
Rh	5	Relative humidity	%
Wd	6	Wind direction	degrees
Ws	7	Wind speed	m/s
Press	8	Air pressure	mbar

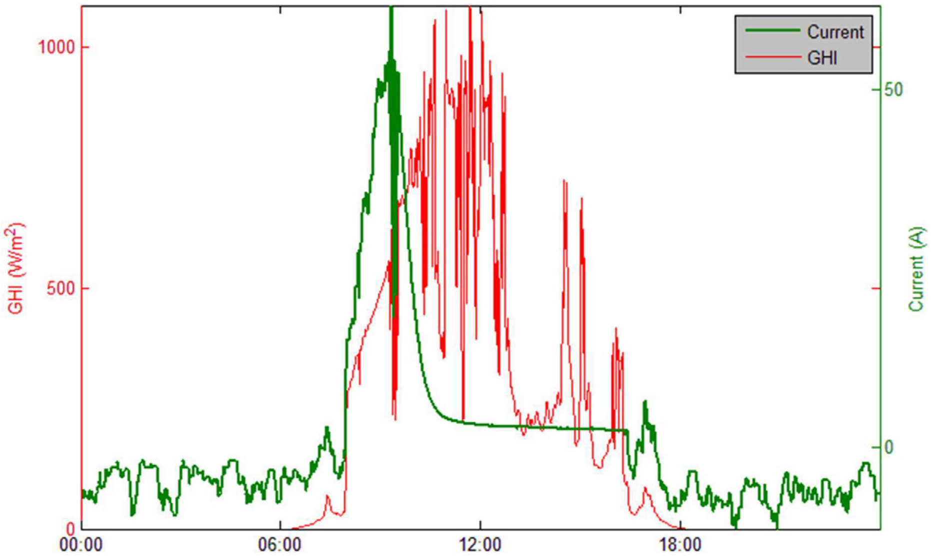

Fig. 1. Measures of irradiance GHI and battery current (1st of May 2020).

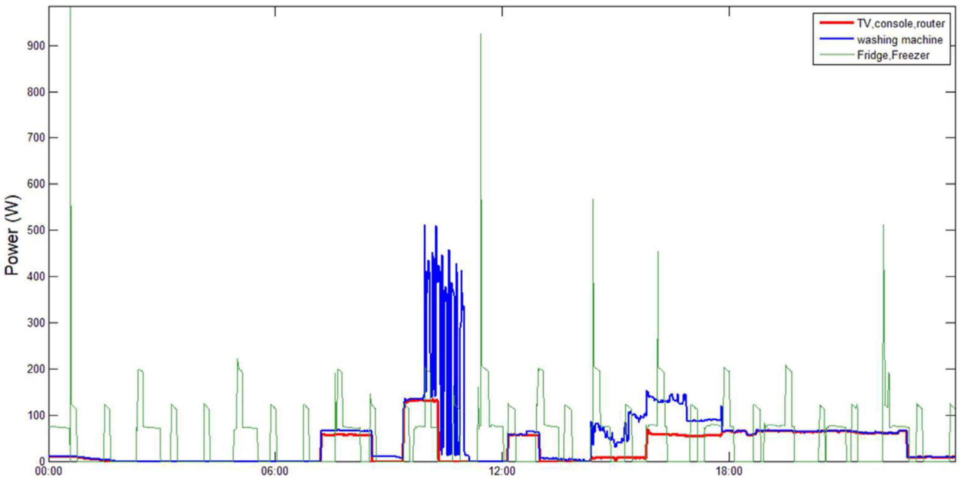

Fig. 2. Monitoring of appliances usage for home 1 (1st of May 2020).

Table 2
Variables of the “Solar_plant_dataset” file.

Variable	ID	Designation	Unit
P_{out}	9	Output power of the inverter	kW
P_{pv1}	10	Output power of the 1st solar regulator	kW
P_{pv2}	11	Output power of the 2nd solar regulator	kW
U_{pv1}	12	Output voltage of the 1st solar regulator	V
U_{pv2}	13	Output voltage of the 2nd solar regulator	V
U_{bat}	14	Battery voltage	V
I_{bat}	15	Battery current	A
T_{bat}	16	Battery temperature	°C

Table 3
Variables of the "Demand_house_dataset" file.

Label	ID	List of appliances	Unit
House n°1			
Input 1	17	TV, Games console, TV router	W
Input 2	18	Washing machine, TV	W
Input 3	19	Freezer, Fridge	W
Input 4	20	Main (all appliances)	W
House n°2			
Input 1	21	TV	W
Input 2	22	Light 1	W
Input 3	23	Light 2	W
Input 4	24	Socket	W
Input 5	25	Main (all appliances)	W
House n°3			
Input 1	26	Main (all appliances)	W
Input 2	27	Freezer, Fridge	W
Input 3	28	Socket	W
Input 4	29	Light	W

are available via a web portal in the cloud. Household aggregate energy consumption is also reported.

The sampling rate of 20 s is for meteorological data and 1-minute intervals for the other ones. All the data is available in comma-separated format. A ReadMe TXT file is included in the deposit to give detail about the different datasets.

As data illustrations, Fig. 3 represents the solar irradiance for 24 hours (1st of May 2020). The battery current parameter gives the activity of the storage device. It is also indicated in this graph. Data show the bidirectional flow of energy through the sign value of current. Fig. 4 gives energy consumption for home n°1. Three usage modes are represented, recreational activity (TV, console), household activity (washing machine) and permanent energy use (fridge, freezer).

Fig. 3. Aerial view of the microgrid. Battery pack and acquisition devices at the centre, the loads at the three ends.

4. Experimental Design, Materials, and Methods

To use solar resources, photovoltaic equipment is composed of 2 strings of 14 polycrystalline panels (1 roof-mounted and 1 ground-mounted). Each panel string represents a power of 3.5

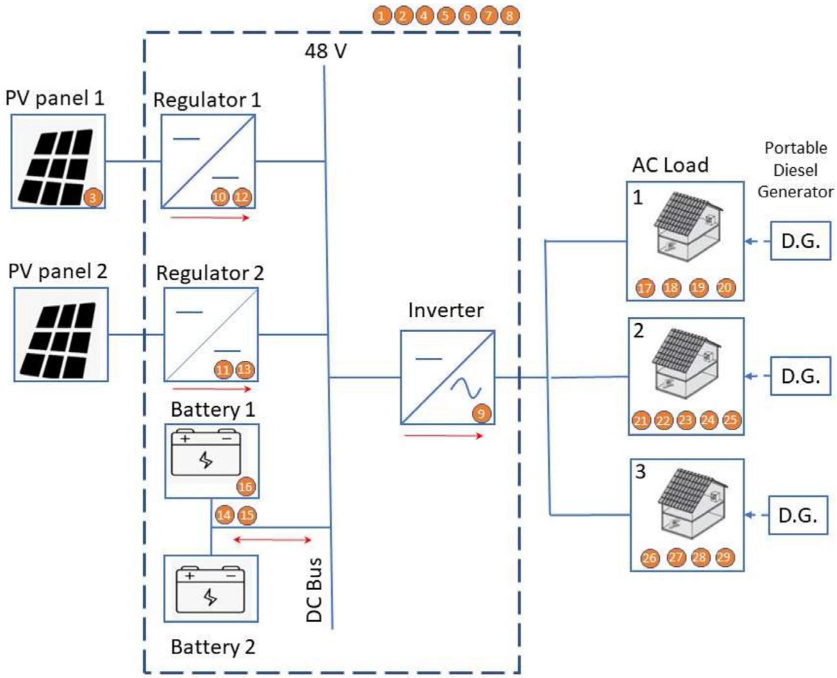

Fig. 4. Structure of the microgrid and data collection point (ID), see Tables 1–3.

kWp. The PV panel brand used is an *Atersa A-260P*. The solar charge controller MPPT model is *VS-70* and the inverter *VS–120* is from *VarioString* manufacturing. Energy storage is provided by 2 lead gel battery packs 48V wired in parallel, with a nominal capacity of 1320Ah (*OPzS*).

A Datalogger CR800 measures and verifies all the sensors via an interface NL201 which allows it to communicate with peripherals over a local area network or a dedicated Internet connection (Fig. 5). The data are transferred to a remote server using the FTP protocol. For meteorological data, two pyranometers *CS301* measure global solar radiation in a horizontal and inclined plan with sensitivity around 5 W m^{-2} mV^{-1}, a hygrometer *CS215* measures ambient temperature and relative humidity, pressure sensor CS106 gives barometric pressure from 500 mbar to 1100 mbar with the working temperature from –40 to 60°C and a total accuracy of ±0.3 mb @ 20°C, a surface thermometer *110PV* provides the photovoltaic module temperature under the panel with a range from -40 to 135°C. A wind sentry anemometer provides wind speed of up to 50 m/s and

Fig. 5. Meteorological sensors and systems (a pyranometer on the left, the anemometer and the data logger on the right).

direction: it consists of a 3-cup anemometer and a wind vane, the accuracy for wind speed is around ±0.5 m/s and for wind direction is ±5 °.

For microgrid data, the parameters are recorded in the solar plant thanks to the *Studer Xtender XTM* device via the *Studer RCC-02/03* which allows access to the numerous programmable parameters, see Table 2.

The household consumptions of the microgrid are obtained by submetering. The device used is *Ewattch squid* which allows us to carry out the electrical sub-metering on each house. Electrical load measurements provide measurements for groups of appliances because it was not possible to provide one electric meter for only one appliance in the private houses. An optimal mesh of the domestic electrical network has been generated minimizing the impact on the daily life of inhabitants. Measures depend on the location and clustering of appliances. Recorders were installed in the junction box if possible or in the electrical switchboard, see Fig. 6. It uses *LoRaWAN* to communicate with a central hub system. All data are then stored in the Reunion University server via communication gateway and GPRS transfer network.

Fig. 6. Consumption recorder: Installation.

The data logger stores the weather measurements in CSV files. Python scripts have been developed to check the CSV files' sanity before being transferred to the remote database. From raw CSV files, the presence of reading for every column/variable at each timestamp is checked. In the case where excessive data gaps are read, a Python script sends mail notifications to request an operator intervention to check the issue. Csv files are sliced into month periods to avoid having too heavy files in the remote database. However, the weather data shared with the community are combined in a unique 1-year-file. The processing demand and power facility data have their own online platform for storage and visualization. *Studer Cloud* for power utility data and *Ewattch Cloud* for individual demand measurement. Python scripts are developed to regularly use the API accesses to transfer data stored online to the University's remote database which ensures having duplicates. In addition, all data are stored in CSV files.

Ethics statements

This article does not contain any studies with human or animal subjects. The datasets are open to the public. For the usage of these datasets, proper citation rules are expected.

Data availability

Data in experimental stand-alone microgrid (Original data) (Zenodo)

CRediT Author Statement

Didier Calogine: Supervision, Conceptualization, Funding acquisition, Project administration, Methodology, Investigation, Software, Writing – original draft; **Johann Francou:** Methodology, Software, Investigation, Writing – review & editing; **Cedric Abbezzot:** Methodology, Software, Investigation, Writing – review & editing; **Tovondahiniriko Fanjirindratovo:** Methodology, Investigation, Software, Writing – review & editing.

Declaration of Competing 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.

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