Data in Brief 32 (2020) 106150

Contents lists available at ScienceDirect

Data in Brief

journal homepage: www.elsevier.com/locate/dib

Data Article

Electricity consumption data of a student residence in Southern Africa

S.O. Masebinu[a,b,*], J.B. Holm-Nielsen[b], C. Mbohwa[c], S. Padmanaban[b], N. Nwulu[d]

[a] Process, Energy and Environmental Technology Station, University of Johannesburg, South Africa
[b] Center for Bioenergy and Green Engineering, Department of Energy Technology, Aalborg University, Esbjerg, Denmark
[c] Department of Quality and Operations Management, University of Johannesburg, South Africa
[d] Electrical and Electronic Engineering Department, University of Johannesburg, South Africa

ARTICLE INFO

Article history:
Received 29 June 2020
Revised 27 July 2020
Accepted 4 August 2020
Available online 8 August 2020

Keywords:
Electricity consumption
Real-time data
Renewable energy
Energy efficiency
Data analysis

ABSTRACT

The time-series dataset presented in this article was captured using a real-time energy monitoring device from a distribution panel of a student residence in Johannesburg, South Africa. The data was captured from April 2016 to January 2018. The data from the three conductors supplying the student residence with electricity was automatically aggregated and presented as a single data point. The granularity was at resolution levels of watt-minute and kilowatt-hour. A total of 13,966 hrs of data points was captured. The data has not been processed further. Hence, data consists of 1,209-hour of missing data points. In addition to the energy consumption data, 16 months of hourly data for wind speed, temperature and humidity of the closest weather station has been provided. The data will be useful in the formulation of mathematical models of electricity consumption that is most suitable for a student residence. Furthermore, the data provided in this article will encourage the development of a data-driven electricity consumption management strategy and policy formulation for student residences.

* Corresponding author. S.O. Masebinu.
E-mail address: smasebinu@uj.ac.za (S.O. Masebinu).

https://doi.org/10.1016/j.dib.2020.106150

Subject	Energy Engineering
Specific subject area	Energy data analysis
Type of data	Table
How data were acquired	The data was acquired using an Efergy Engage Hub Kit. The instrument has a 98% measurement accuracy, according to the manufacturer specification sheet.
Data format	Raw time series data in .csv format. The data is available in minutes and hourly resolutions.
Parameters for data collection	Electricity usage pattern and environmental conditions were the main conditions considered in the data collection. The variation in the student residence occupancy was not considered.
Description of data collection	Three current transformers were attached to each phase of conductor wire supplying the student residence with electricity. The current transformers were connected to a single data transmitting hub. A data receiver collects the data automatically from the transmitting hub and uploads to cloud. An Efergy Engage App was used to visualise the data and download the raw data directly from the cloud server.
Data source location	Institution: University of Johannesburg Region: Gauteng Country: South Africa Latitude and longitude for collected data: 26.1836° S, 27.9977° E
Data accessibility	Repository name: Mendeley Data Data identification number: doi: 10.17632/hwy83hpc6f.1 Direct URL to data: https://data.mendeley.com/datasets/hwy83hpc6f/draft?a=63781636-880a-40ca-9768-a601bf26fd93 Instructions for accessing these data: The data does not have any access restriction.

Value of the Data

- The real-time data provided in this article will aid the development of mathematical models suitable for a student residence electricity consumption profile [1].
- The real-time data provided in this article is useful in the development of energy management strategies and for the design, sizing, modelling, and simulation of alternative energy systems for a student residence [2,3].
- The real-time data provided in this article can be useful in studying response behaviour of alternative sources of energy in response to a case of load-shedding or an abrupt disruption in the supply of grid electricity [3].
- The real-time data provided in this article is useful to researchers and teachers on data science related to electricity consumption data [4].
- The environmental data provided can be used as an independent variable in modelling the electricity consumption of a typical student residence.

1. Data description

The real-time electricity consumption data for a student residence in Auckland Park, Johannesburg, South Africa is presented [5]. The student residence is occupied by students of the University of Johannesburg. The student residence consists of 17 rooms (inclusive of a kitchen and a washing bay) and 4 toilets and bathrooms. An asset assessment of the student residence is summarised in Table 1. The electrical energy consumption data presented, was gathered using a real-time energy monitor. An Efergy Engage app was used to visualise the data and download the data directly from a cloud server as a .csv file. The data consists of watt-minute and watt-hour energy consumption from April 2016 to January 2018. A total of 13,966 hrs of data points

Table 1
Electrical loads of the student residence.

Individual room Appliances	Counts	Power range (W)	Avg. kWh/day
Refrigerator	10	90–120 W	9.90 – 13.20
Microwave	13	1200 –1300 W	1.82 – 1.97
Flat iron	15	2200 - 2400	3.30 – 3.60
Laptop	15	45 - 90 W	2.70 – 5.40
Bread Toaster	5	750 W	0.31
Sound system	8	150 - 280	0.60 – 1.12
CFL Lightings	17	10 - 30 W	1.36 – 4.08
TV	5	220 W	2.20
Fan	4	50 W	0.20
Phone charger	15	5 - 10 W	0.04 – 0.08
Kettle	13	1850 - 2000 W	4.01 – 4.33
2-plate electric cooker	2	1 850 W	1.85
Electric heater	15	400 – 1200 W	18.00 – 54.00
General Appliances			
4-plate electric stove	2	2200 W	22.00
Washing machine	1	600 W	1.20
Refrigerator	1	120 W	1.32
Double Florescent lightings	7	N/A	3.36
CFL Lightings	8	10–25 W	0.56 – 1.40
Geyser	2	3000 W	18.00

The table provides the list and counts of electrical appliances at the student residence. The power rating of each appliance differs, hence, a power range for similar appliances has been provided based on an energy audit conducted at the residence. Approximated energy consumption of the electrical appliances has been provided. The aggregated energy consumption of the residence was captured using the energy monitor.

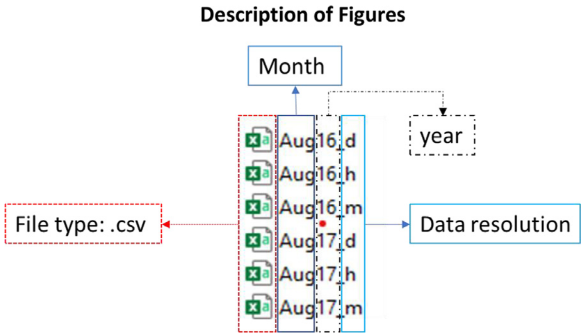

Fig. 1. File type and naming convention description
The figure provides a description of the denotation of the three types of CSV files. The naming convention is month, year and minute (m) or hour (h) or day (d).

was captured. The data also contains 1,209-hour points of missing data. Two factors contributed to the missing data, namely scheduled load shedding from the utility company providing electricity to the area [6,7] and the exhaustion of internet data for router connectivity. The data has not been statistically analysed for any inference. However, average energy consumption per day of the appliances has been provided considering the variation of usage. In Table 1, the electric heaters are mostly used only during the austral winter season (June, July and August). Aside, the austral winter season, the heaters are only used on a few occasion of cold fronts typically experienced in South Africa.

The file naming convention for the energy data is monthyear_time, as shown in Fig. 1. For example, April16_m represents data collected for April 2016 with energy consumption presented in watt-minute, as shown in Table 2A. April16_h represents data collected for April 2016 with the energy consumption presented in kilowatt-hour, as shown in Table 2B. April16_d represents

Table 2
Sample of energy consumption data and units.

A		B		C	
Timestamp	Power (Wm)	Timestamp	Power (kWh)	Timestamp	Power (kWh)
01–08–16 0:00	1989	01–08–16 0:00	3.25	01–08–16 0:00	174.61
01–08–16 0:01	1997	01–08–16 1:00	4.68	02–08–16 0:00	175.12
01–08–16 0:02	1833	01–08–16 2:00	2.38	03–08–16 0:00	166.53
01–08–16 0:03	2567	01–08–16 3:00	3.29	04–08–16 0:00	199.51
01–08–16 0:04	6169	01–08–16 4:00	3.08	05–08–16 0:00	172.31
01–08–16 0:05	6267	01–08–16 5:00	3.36	06–08–16 0:00	175.24
01–08–16 0:06	6294	01–08–16 6:00	5.85	07–08–16 0:00	182.85
01–08–16 0:07	6270	01–08–16 7:00	10.97	08–08–16 0:00	153.9
01–08–16 0:08	6361	01–08–16 8:00	11.92	09–08–16 0:00	137.39

The table gives an insight into the raw energy consumption data structure. Column A represents the energy consumption in Watt-minute for every minute time stamp. Column B represents the hourly energy consumption presented in kilowatt-hour. Column C is the aggregated daily energy consumption presented in kilowatt-hour.

Table 3
Sample of environmental data.

DD	h01	h02	h03	h04	h05	h06	h07	h08	h09	h10	h11	h12
1	17.6	17.5	17.5	17.1	16.4	16.0	17.5	17.8	18.3	14.2	15.8	18.0
2	18.3	17.8	17.1	17.0	17.2	17.6	18.2	18.6	19.4	20.3	21.2	24.1
3	18.3	18.1	17.9	17.4	17.1	17.3	20.7	23.0	25.1	26.2	27.8	27.7
4	14.9	14.2	13.9	13.6	13.4	13.4	18.2	20.8	24.6	27.4	29.0	29.5
5	18.3	18.7	18.8	17.7	17.2	17.0	20.7	22.4	24.6	25.7	27.5	28.8
6	18.5	17.9	17.4	17.3	17.5	17.8	21.2	24.1	26.3	27.6	29.0	30.3
7	19.6	18.8	18.2	18.3	17.9	18.0	20.8	22.2	24.2	24.1	25.7	26.2
8	17.8	17.3	17.2	17.2	17.1	17.4	20.4	21.4	22.4	24.6	25.2	26.8
9	19.7	19.2	19.3	19.3	19.4	19.6	21.8	24.3	23.0	24.6	24.7	26.8
10	19.8	18.8	16.9	17.0	17.3	17.7	18.9	21.2	22.8	24.3	26.6	27.9

DD – Day of the Week; h01, h02…h024 is the hour of the day.
The table gives an insight into the raw environmental data structure. The columns represent each hour of a day while the rows represent each day in a month. The temperature data are in degree Celsius.

data collected in April 2016 with the aggregated energy consumption for each day of the month in kilowatt-hour, as shown in Table 2C. Therefore, April16_d will contain daily energy consumption data for each day of the month. Environmental data for ambient temperature, wind speed and humidity has also been provided. A sample for a ten-day data points over a 12-hour period is shown in Table 3.

2. Experimental design, materials and methods

The energy monitor consists of three equipment, as shown in Fig. 3, namely a current transformer (CT) scanner (12–19 mm conductor diameter, nominal current of 90–120 A for the 12 mm CT and 120–200 A for the 19 mm CT), a transmitter with 70 m radius operating range, and a receiver (wireless frequency 433.5 MHz, a measurement range of 50 mA to 120 A per phase and a voltage range of 110–300 VAC) [8]. Table 4 summaries the technical specification of the energy monitor system. The layout of the energy monitoring system is presented in Fig. 2. Three current transformers were attached to the conductor wires supplying the student residence with electricity, as shown in Fig. 4. The current transformers were connected to a single data transmitting hub. The student residence uses a single load point distribution board; therefore, all electricity consumption of the residence was distributed across the three conductors with a CT scanner. The receiver unit collects the data automatically from the transmitting hub and uploads to the cloud through a router, as shown in Fig. 5. From the cloud system, the data can be remotely accessed

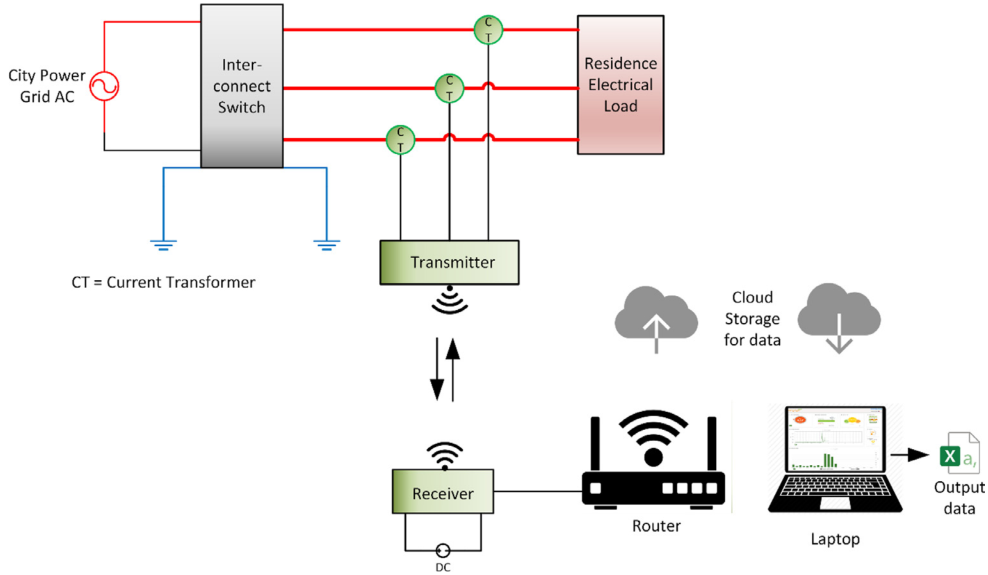

Fig. 2. Schematic diagram for the layout of the energy monitoring system
The figure descriptively explains how the energy monitoring system was connected and how data was exchanged.

Fig. 3. Energy monitoring kits
The figure shows the data capturing device which include three current transformers, a transmitting hub, and a receiving hub. The device was manufactured by Efergy.

Table 4
Technical specification of the energy monitoring system.

Components	Current Transformer	Transmitter	Receiver
Conductor diameter	12 – 19 mm		
Nominal Current	90–120 A (12 mm)		
	120–200 A (19 mm)		
Voltage	110–300 VAC		5 VDC
Frequency	60 Hz		
Transmitter Operating Range		40 - 70 m	
Transmission/receiver time		12 s	12 s
Wireless Frequency			433.5 MHz
Measurement range per phase			50 mA – 120 A
Measurement accuracy	>90%		

The table provides the specification and operating range of the energy monitor.

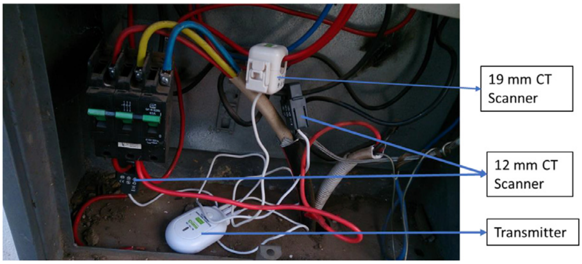

Fig. 4. CT scanners and transmitter
The figure shows the experimental set-up at the student residence.

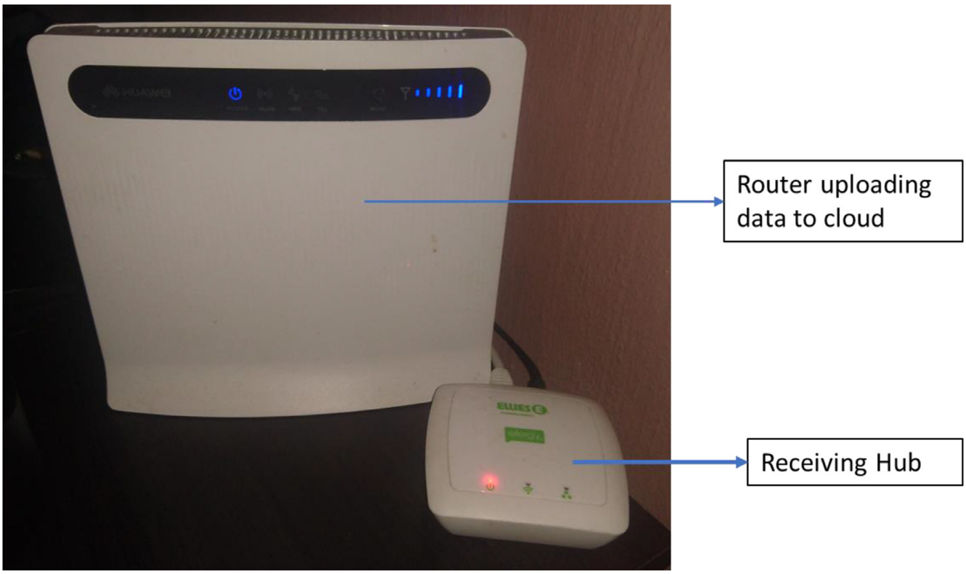

Fig. 5. Energy consumption data receiver and uploading to cloud system
The figure shows the data receiver and the internet route. The internet route enables the transfer of captured energy consumption data to the cloud.

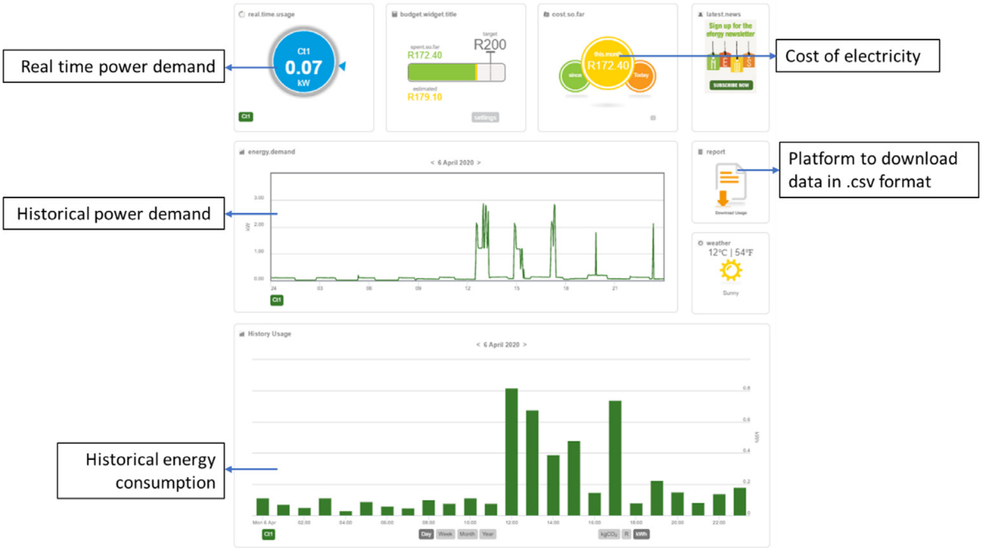

Fig. 6. Online interface for remote real-time data visualisation
The figure shows the online interface for remote viewing in real-time, the power demand and electricity consumption. Also, through this platform, the electricity consumption data can be downloaded.

through a web browser, as shown in Fig. 6 or via an app on a smartphone or tablet. At the end of installation and synchronisation, an accuracy test was conducted. The test involves switching off known loads in Table 1 and the reduction in the captured real-time data was concurrent to the power demand of the respective appliances. The online monitoring interface as presented in Fig. 6, shows the real-time power demand of the entire residence, it provides historical power demand profile as well as historical electrical energy consumption. The electricity consumption data can be aggregated as per minute, hour, day, and month. The electricity consumption data was downloaded as a .csv file.

The environmental data was obtained from the closest weather station, Johannesburg Botanical Garden, operated by the South African Weather Service. The weather station is referenced with a climate number of 04758790 at a coordinate of −26.1560, 27.9990 (latitude, longitude) and at a height of 1,624 m above sea level. The botanical garden is approximately 4 km away from the student residence. Details of the environmental data capturing system were not provided.

Declaration of Competing Interest

The authors declare that they have no known competing financial interest or personal relationship which have, or could be perceived to have, influenced the data reported in this work.

Acknowledgements

This project was carried out under the Project No. 19-MG04AAU, Danida Mobility Grant, sponsored by the Ministry of Foreign Affairs of Denmark (MFA), under Act 7 on Denmark's International Development Cooperation.

The authors acknowledge the Process, Energy and Environmental Technology Station at the University of Johannesburg, the South African Weather Service and the center for Bioenergy and

Green Engineering, Department of Energy Technology, Aalborg University, Denmark, for supporting this research work.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.dib.2020.106150.

References

[1] O.O. Ayeleru, J.A. Adeniran, S. Ntsaluba, J.J. d. Koker, Comparative study on energy consumption at the University of Johannesburg residences, in: 2017 International Conference on the Domestic Use of Energy (DUE), 2017, pp. 67–75.
[2] A. Yakubu, E. Ayandele, J. Sherwood, O.A. Olu, S. Graber, Minigrid investment report: Scaling the Nigerian market, Rocky Mountain Institute, Nigeria, 2018.
[3] S.S. Nunayon, Dataset on the patterns of electricity consumption in public universities in southwestern Nigeria, Data Brief 21 (2018) 1–7 2018/12/01/.
[4] S.O. Masebinu, E.T. Akinlabi, E. Muzenda, A.O. Aboyade, Techno-economic analysis of grid-tied energy storage, Int J Environmental Science and Technology (2017) July 24.
[5] S.O. Masebinu, E.T. Akinlabi, E. Muzenda, A.O. Aboyade, Techno-economics and environmental analysis of energy storage for a student residence under a South African time-of-use tariff rate, Energy 135 (2017) 413–429 2017/09/15/.
[6] Eskom, Eskom Loadshedding Schedule 29 April, 2020 Available: http://loadshedding.eskom.co.za/ .
[7] 29 April, Load shedding status, 2020 Available: https://www.citypower.co.za/customers/Pages/Load_Shedding_Downloads.aspx .
[8] Efergy, E2 wireless electricity monitor, 2014 Efergy, Ed., ed.