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# IoT-Enabled Weather-Informed Automatic Switching and Priority Load Management for Hybrid Solar–Wind Power Systems

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**ABSTRACT:** This paper provides a Hybrid solar-wind generation with battery backup and prioritised load switching enabled Internet of Things (IoT)-enabled control. The weather data has been sent to a cloud API to a Raspberry PI Pico W that also receives electrical data via voltage and current sensing circuits. The controller picks the sources of accessible energy and only links noncritical loads when there is enough production(generation), and leave the backup supply to be used by critical loads. The prototype which is being reported is based on monitoring and use of load which is controlled with relay and the use of IoT dashboard. The source manuscript presents four days of time with documented renewable power and power range of 75-100 W, 100-300 W, 200-350 W as well as 200 W during day time. A consistency audit finds various switching points which need to be changed, before claims of continuous service or efficiency gain could be proven. The difference between the reported observations and the corrections which are proposed are explained in this paper and an evaluation protocol that will be reproducible in the future is specified.

## 1. INTRODUCTION

Solar and wind resources are variable making it difficult to supply electricity to the loads continuously. Richer diversity of resources can be served by utilizing hybrid renewable systems [1], but switching between sources should take into consideration the power available at any given moment, the state of charge in the batteries and the priority of loads. IoT connectivity helps in remotely monitoring, as well as retrieving weather forecasts [2]. Actual renewable production needs to be measured to prevent connecting loads that exceed the capacity or such electrical feedback is not a replacement to weather forecasting as it is advisory [3]. This paper outlines a prototype hybrid energy management that is weather informed and audits its reported power and switching data. The overall contribution is the well-defined policy of control by priorities which can be checked with the measured operating conditions.

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## 2. SYSTEM ARCHITECTURE AND METHODOLOGY

The architecture that is being reported unites photovoltaic and wind-generated power with charge controllers, a battery bank, DC-DC conversion, inverter circuitry and switching relays, a Raspberry Pi Pico W (RP2040), ACS712 current sensors [4], voltage sensing circuits, ADS1115 analog-to-digital conversion [5], and a cloud-connected monitor dashboard. The Pico W is a microcontroller board, rather than a full single-board computer, Raspberry Pi. Weather data is made available by a web API; solar irradiance does not always have to be provided by all weather APIs and has to be measured, simulated or taken out of a suitable dataset. The original document contains a three phase inverter in its design and 220 V AC inverter in its design; a verification of the type and rating of the inverter used is necessary.

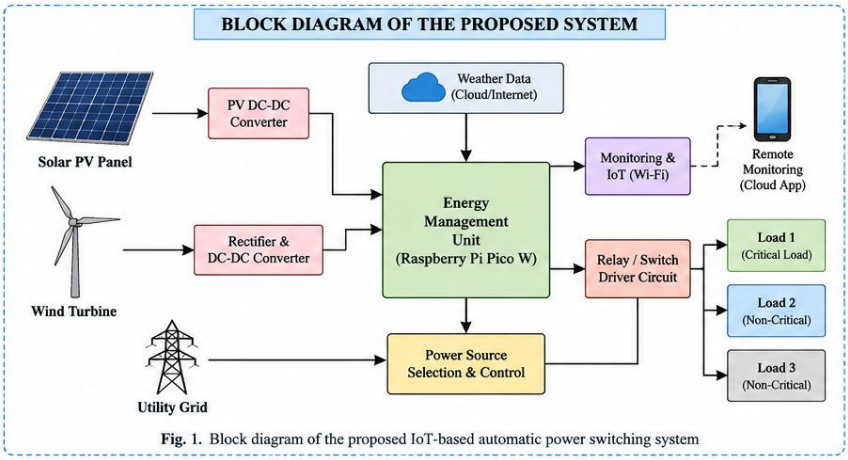



**Figure 1**. Functional block diagram of the proposed IoT-enabled hybrid renewable energy system.

**Proposed system operation.** The functional arrangement in Figure 1 separates energy conversion, supervisory control, and load switching. Solar and wind generation feed their respective conversion stages, while the controller receives local electrical measurements and available weather information. The proposed energy management unit uses these inputs to select an allowable supply path and determine which loads can be connected. The critical load receives the highest priority, followed by the two noncritical loads. The monitoring interface is intended to display source availability, electrical measurements, and relay status. Remote monitoring supports supervision; local measurements and protection limits remain the basis for switching decisions.

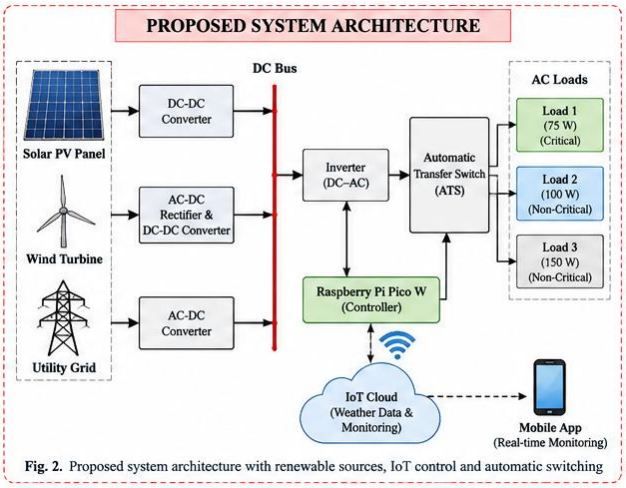



**Figure 2**. Proposed system architecture (conceptual; grid conversion and transfer protection require engineering verification).

**Proposed architecture and energy coordination.** Figure 2 illustrates a conceptual common DC bus linking renewable conversion stages with the inverter and AC loads. The controller coordinates source selection and priority scheduling, while the cloud interface supplies weather information and receives monitoring data. In the proposed implementation, battery state

of charge and source ratings must also constrain the scheduling decision; the battery connection and its protection require explicit design because they are not fully detailed in this conceptual figure. When renewable generation falls, noncritical loads are disconnected in priority order. A battery or permitted grid supply may support the critical load only when its operating limits and transfer protections allow this.

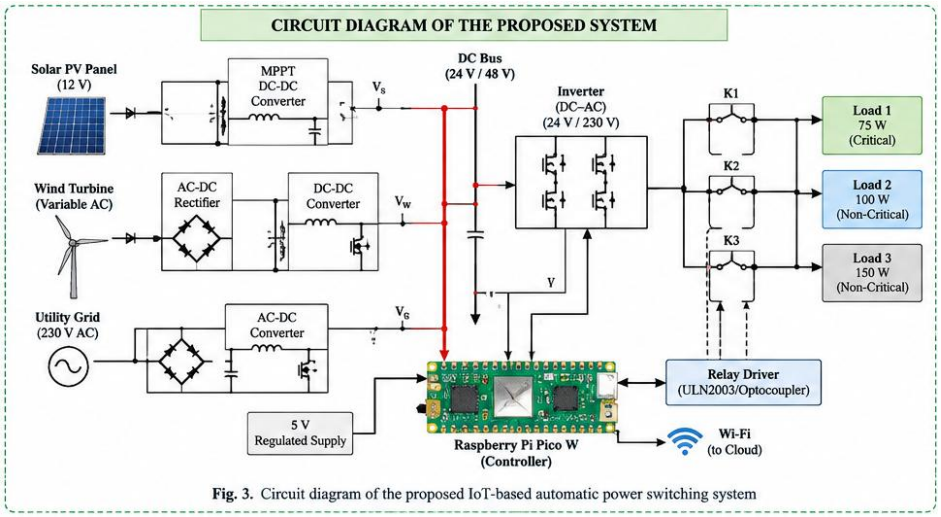



**Figure 3.** Illustrative circuit topology (not a verified build-ready wiring schematic).

**Proposed sensing and switching arrangement.** The illustrative topology in Figure 3 shows how renewable conversion stages, the DC bus, an inverter, and relay-controlled loads relate to one another. Voltage sensing and ACS712 current sensing are intended to provide electrical feedback, with ADS1115 conversion supporting the controller input interface [4], [5]. The controller would compare measured available power with the cumulative load demand before issuing relay commands through a suitable driver. The final design must specify sensor scaling, electrical isolation, converter ratings, battery protection, and relay interlocking. These requirements define the intended implementation and do not establish that the depicted circuit has been electrically verified.

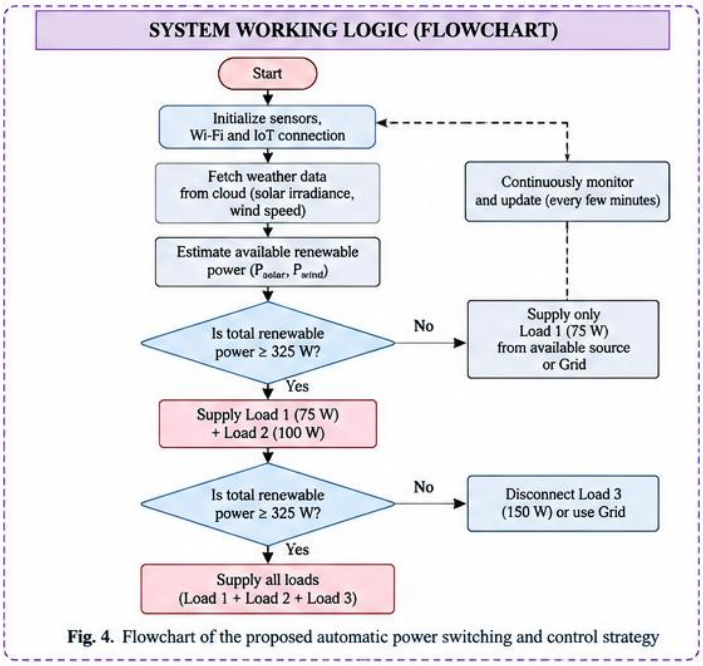



**Figure 4.** Illustrative controller flowchart (power thresholds must be corrected to 75 W, 175 W and 325 W before implementation).

Verification Figure: They are conceptual presentation figures. Specifically, the flowchart graphic has 325 W comparisons which are repeated and it is not the end corrected switching policy. Table 1 is used to give the proposed logic of numerically switching as authoritative. Power-electronics topology, isolation, protection, wiring and rating has to be checked prior to the fabrication or submission as a tested circuit.

Measured renewable output PRES, overall connected load P L, battery state of charge SOC and grid availability should be used by the controller. The future weather information on the sun and wind could be used to make proactive decisions but measured electrical availability, protective interlock and a reserve margin should be used as a basis to apply relay actuation. The switching delay, minimum dwell time, fault operation and safe break before make operation must be defined.

## 3. PRIORITY-BASED SWITCHING POLICY

For the three reported loads, L1 = 75 W, L2 = 100 W, and L3 = 150 W, the cumulative power thresholds are 75 W, 175 W, and 325 W, respectively. These are all hypothetical minimums and do not include converter losses, transient currents and safety reserve. The set limit of 500-W used in the original paper is not in agreement with the total load of 325 W in the connected load; the purpose of this should be explained.

**Table 1.** Illustrative priority switching schedule that is physically consistent schedule, based on given load ratings; is not a record of observed instances of switching. Before deployment, the thresholds have to be raised by an engineering reserve.

| Measured available RES power | L1 (75 W) | L2 (100 W) | L3 (150 W) | Minimum demand |
|---|---|---|---|---|
| Below 75 W | OFF | OFF | OFF | 0 W |
| 75 to below 175 W | ON | OFF | OFF | 75 W |
| 175 to below 325 W | ON | ON | OFF | 175 W |
| 325 W or above | ON | ON | ON | 325 W |

Suggested control behavior: (1) read electrical sensors and data verification; (2) fetch timestamped weather forecast (where provided); (3) decide which path is allowable to supply the load, within source and battery limits; (4) schedule loads with priorities and reserve margin; (5) enforce relay interlocks and dwell time; (6) report measurements and switching events to the dashboard; (7) enter a programmed safe state on a communication error or sensor error.

## 4. REPORTED RESULTS AND DATA AUDIT

The values below are copied out of the given manuscript. They do not contain timestamped raw sensor records, but just interval summaries. There is conservation of ranges, rather than assigning measurement errors or created central positions.

**Table 2.** Reported generation observations that have been made originally. Wb/m2 is the original header, but this has been changed to the standard unit of irradiance w/m to ensure that this value is irradiance, and should be confirmed by the author.

| Time interval | Reported solar irradiance (W/m²)* | Wind speed (m/s) | Reported RES power (W) |
|---|---|---|---|
| 09:00–11:00 | 850 | 5 | 75–100 |
| 11:00–14:00 | 1000 | 4 | 100–300 |
| 14:00–16:00 | 900 | 5 | 200–350 |
| 16:00–18:00 | 750 | 5 | 200 |

The upper maximum bound is 350 W recorded between 14: 00 -16:00. Nevertheless, there is a lack of reporting of sampling rate, the calibration of instruments, provenance of the weather-data, history of the battery SOC, the inverter efficiency and the switching-event log. Based on this, the energy yield, switching response time, reliability and percentage efficiency improvement, could not be reliably calculated based on the four interval summaries.

The table of physical inconsistencies in the source switching table is the 75-W load in the 50100 W band is set to ON, and the entire 325-W load in the 300350 W band is set to ON. Moreover, the prose which comes with it falsely states that the three loads can work over the 200350 W. The following illustrated corrupted schedule has been put on a corrected basis, and should not be reported as experimental results.

## 5. DISCUSSION AND LIMITATIONS

The energy scheduling could use cloud forecasts, but the source document does not determine the accuracy of the forecast, or demonstrate a result comparing the forecast with a reactive base. Control based on weather is prone to API latency, absence of data and error in forecast. The relay transfer can never be termed as uninterrupted unless the measurement of transfer time exists and there are indications of a suitable UPS or hold-up set up. Other necessary electrical design checks are critical-load continuity, protective coordination, battery limits and isolation of the public grid. The purported decrease in waste, increased efficiency and resilience should be considered as design goals prior to being confirmed by comparable quantitative measures.

## 6. RECOMMENDED VALIDATION DATASET

| Variable | Suggested unit | Purpose |
|---|---|---|
| Timestamp and interval | ISO 8601 / s | Synchronize observations |
| PV voltage and current | V, A | Compute PV power |
| Wind voltage and current | V, A | Compute wind power |
| Load power per channel | W | Verify actual demand |
| Battery SOC and current | %, A | Assess backup contribution |
| Weather source and forecast lead time | provider, min | Assess forecast validity |
| Switching command and feedback | timestamp, state | Measure transfer time |
| Grid state and fault events | state, code | Evaluate reliability |

The recommended comparisons are: forecast-informed and measurement-only switching; transitions that are not necessary; the energy consumed without meeting the critical load (Wh); rate of renewable usage (percent); relay transfer latency (milliseconds); and behavior during API flaws. These metrics should not be reported until the time of raw data.

## 7. CONCLUSION

The hybrid build of solar-wind prototype offered features a hybrid of cloud weather data, local electrical monitoring system, a system to switch between relays and IoT-based visualization. The data reported show that the highest possible power outputs of renewable energy were up to 350 W at one point in the afternoon. A data audit reveals that the initial switching set thresholds need adjustment in order to adhere to the load ratings of 75-W, 100-W and 150-W. A redefined control framework offers a falsifiable foundation to priority load control; arguments about efficiency increases, resilience to errors, and non-stop operation are yet to be proven through controlled experiments, with time-resolved measurements.

## REFERENCES

[1] P. Bajpai and V. Dash, "Hybrid renewable energy systems for power generation in stand-alone applications: A review," Renewable and Sustainable Energy Reviews, vol. 16, no. 5, pp. 2926–2939, 2012, doi: 10.1016/j.rser.2012.02.009.

[2] A. J. Albarakati et al., "Microgrid energy management and monitoring systems: A comprehensive review," Frontiers in Energy Research, vol. 10, Art. no. 1097858, 2022, doi: 10.3389/fenrg.2022.1097858.

[3] K. J. Iheanetu, "Solar photovoltaic power forecasting: A review," Sustainability, vol. 14, no. 24, Art. no. 17005, 2022, doi: 10.3390/su142417005.

[4] Allegro MicroSystems, "ACS712: Fully integrated, Hall-effect-based linear current sensor IC." [Online]. Available: https://www.allegromicro.com/en/products/sense/current-sensor-ics/zero-to-fifty-amp-integrated-conductor-sensor-ics/acs712. Accessed: Oct. 30, 2026.

[5] Texas Instruments, "ADS1115: 16-bit, 860-SPS, 4-channel, I2C ADC with PGA." [Online]. Available: https://www.ti.com/product/ADS1115. Accessed: Oct. 30, 2026.