Core Components and Microcontroller

To build a smart environmental monitoring system, the central processing unit is the **ESP32** microcontroller, chosen for its integrated Wi-Fi and Bluetooth capabilities, allowing seamless communication and connectivity. The ESP32 operates on a voltage range of 3.3V to 5V and is priced at approximately $5.00. To monitor environmental parameters, the system incorporates several sensors: a **temperature sensor** and a **humidity sensor**, both of which use the I2C interface and require 3.3V to 5V. The estimated cost for each of these sensors is around $2.00. An **air quality sensor** detects pollutants and is typically interfaced via UART or I2C, also operating at 3.3V to 5V, and costs about $10.00

Additional Sensors and Modules

For measuring carbon dioxide levels, a **CO2 sensor** is used, which communicates via UART or I2C and operates within the same voltage range as other sensors (3.3V to 5V), with an estimated cost of $15.00. The **GPS module** provides location data through a UART interface and requires 3.3V to 5V, priced at $8.00. To display environmental data, an **LCD display** (either 16x2 or 128x64 OLED) is employed, using I2C or SPI communication and operating at 3.3V to 5V, costing around $12.00. An **active buzzer** is included for alerts, powered by 3.3V to 5V, and costs approximately $1.00.

Power Supply, Miscellaneous Components, and Costs

The system's power needs are met by a **power supply** (USB or AC adapter) providing 5V, priced at $6.00, along with a **battery pack** for backup power, typically rechargeable Li-ion or LiPo with a voltage of 3.7V to 5V, costing around $10.00. Additional components include a **weatherproof enclosure** to protect the electronics and sensors, costing $5.00, and a **custom-designed PCB** to connect all components, estimated at $10.00. Various **connectors and wires** ensure proper signal flow and are priced at $3.00, while **mounting hardware** is used to secure the system and costs about $2.00.

Bullet Points

- **Microcontroller (MCU):**
  - **ESP32**: Central processing unit; integrated Wi-Fi/Bluetooth; 3.3V to 5V; $5.00
- **Sensors:**
  - **Temperature Sensor**: Measures temperature; I2C; 3.3V to 5V; $2.00
  - **Humidity Sensor**: Measures humidity; I2C; 3.3V to 5V; $2.00
  - **Air Quality Sensor**: Detects pollutants; UART/I2C; 3.3V to 5V; $10.00
  - **CO2 Sensor**: Measures CO2 levels; UART/I2C; 3.3V to 5V; $15.00
  - **GPS Module**: Provides location data; UART; 3.3V to 5V; $8.00
- **Display:**
  - **LCD Display**: Shows data; I2C/SPI; 3.3V to 5V; $12.00
- **Other Components:**
  - **Buzzer**: Emits alerts; GPIO; 3.3V to 5V; $1.00
  - **Relay Module**: Controls external devices; GPIO; 5V; $5.00

    - **Power Supply**: Provides power; USB or AC adapter; 5V; $6.00
    - **Battery Pack**: Backup power; rechargeable Li-ion/LiPo; 3.7V to 5V; $10.00
- **Miscellaneous:**
    - **Enclosure**: Protects system; weatherproof; $5.00
    - **PCB (Printed Circuit Board)**: Connects components; $10.00
    - **Connectors/Wires**: Ensures signal flow; $3.00
    - **Mounting Hardware**: Secures system; $2.00