**Renewable Energy Data Visualization with User Authentication**

**Front-End Unit Test Cases:**

1. **Login Component:**
   * Verify that the login form is displayed correctly.
   * Ensure that the username and password input fields are present.
   * Test the functionality of the submit button.
   * Validate error messages displayed for invalid inputs.
2. **Registration Component:**
   * Confirm that the registration form is rendered accurately.
   * Validate the presence of input fields for username, email, and password.
   * Test the functionality of the submit button for registration.
   * Verify that appropriate error messages are shown for invalid inputs.
3. **Dashboard Component:**
   * Ensure that the dashboard renders correctly.
   * Test the fetching and rendering of data in charts and graphs.
   * Validate the functionality of filters for adjusting time frame and energy sources.
   * Verify the responsiveness of the dashboard across different screen sizes.
4. **Chart Components:**
   * Validate the rendering of various chart types (line, bar, pie, etc.).
   * Test the rendering and updating of data based on provided props.
5. **Navigation Component:**
   * Test the functionality of navigation links leading to different sections of the application.
   * Ensure that active states are correctly applied to navigation items.
   * Validate the responsiveness of the navigation menu, particularly on smaller screens.

**Back-End Unit Test Cases:**

1. **User Authentication Endpoint:**
   * Validate user registration functionality with both valid and invalid input data.
   * Verify login functionality with both correct and incorrect credentials.
   * Test token generation and ensure tokens expire as expected.
2. **Data Retrieval Endpoint:**
   * Ensure accurate retrieval of energy consumption and generation data for different time frames.
   * Validate filtering of data by energy sources.
   * Validate filtering of data by States.
   * Test error handling for invalid requests made to the endpoint.
3. **Database Interactions:**
   * Test CRUD operations for users in the database, including creation, retrieval, and deletion.
   * Validate the storage and retrieval of energy consumption and generation data.
4. **Authentication Middleware:**
   * Verify that the authentication middleware correctly verifies JWT tokens.
   * Test error handling for unauthorized access attempts.
5. **Data Processing Services:**
   * Validate the functionality of data processing functions to ensure accurate computation of insights.
   * Test edge cases and boundary conditions to ensure robustness of data processing algorithms.

**End to End Test Cases:**

· **User Registration and Login E2E:**

* Initiate the user registration process by completing the registration form and submitting it.
* Perform user login using the registered credentials.
* Confirm successful redirection to the dashboard upon successful login.

· **Data Visualization E2E:**

* Simulate the retrieval of energy consumption and generation data from the backend API.
* Validate the rendering of charts and graphs based on the received data.
* Verify that interactions with filters, such as adjusting time frames and energy sources, trigger appropriate updates in the charts/graphs.

· **User Interaction E2E:**

* Simulate user interactions with various UI components such as forms, buttons, and navigation links.
* Test the complete user journey, including registration, login, and accessing the dashboard.

· **Cross-Browser:**

* Evaluate the application's compatibility by testing it on multiple web browsers (e.g., Chrome, Firefox, Safari).

**Integration Test Cases:**

1. **User Authentication Integration:**
   * Validate the registration process followed by login using the registered credentials.
   * Ensure that the authentication middleware correctly verifies JWT tokens for protected routes.
   * Test access to protected routes without valid authentication to verify unauthorized access handling.
2. **Data Retrieval and Visualization Integration:**
   * Verify the retrieval of energy consumption and generation data from the backend API.
   * Validate the rendering of charts and graphs based on the fetched data.
   * Test interactions with filters (e.g., time frame, energy sources) to confirm that the charts/graphs update accordingly.
3. **Data Storage Integration:**
   * Test the storage and retrieval of user information and energy data from the database.
   * Ensure data integrity and consistency are maintained after performing storage and retrieval operations.
4. **User Interaction Integration:**
   * Validate user interactions with various UI components such as forms, buttons, and navigation links.
   * Test the flow of user actions for processes like registration, login, and accessing the dashboard.
5. **Error Handling Integration:**
   * Test error handling mechanisms for different scenarios such as invalid requests and server errors.
   * Validate that appropriate error messages are displayed to users in case of failures or unexpected situations.