**TEST PLAN FOR HOME ENERGY SETUP:**

This product solution is used for supplying uninterrupted power to the home. The entire system is managed by software that monitors the home load and power output from solar panel, powerwall and the grid.

To completely test this solution, each feature needs to be tested for its functionality in isolation and then also in concurrence with other features.

**TEST STRATEGY:**

There are two main categories or stages that the testing can be divided into: Build Verification Testing (BVT) and Functional Verification Testing (FVT). Whenever a new product build is released, an environment needs to be setup with the new software manually or using automation.

* BVT suite will cover all the basic necessary testing that needs to be done to confirm that the build and major features are working.
* FVT suite is the next step and is only supposed to be run after the BVT suite passes. This suite contains stress testing and concurrence testing scenarios.

To perform the testing, we would need some external components to simulate the scenario. Following hardware and engineering hooks can be used.

* Programmable power supplies can be used to deliver power to simulate solar panel and grid.
* Programmable electronic loads can be used to simulate home load.
* Powerwall with engineering drivers to set and read charging levels are also required.

The test documentation below uses gherkin syntax for direct portability to a Behavior Driven Development framework for test automation. All major tasks are a ‘Feature’, and every specific case is a ‘Scenario’. Thus all the tests are categorized under respective features which not only include individual features, but also concurrent operation. This also makes sure that test documentation, manual testing and test automation – all are in perfect sync.

**SCOPE OF TESTING:**

**In Scope:**

System level testing of all features of energy software. Individual feature testing, Concurrence testing, stress testing of all components of software.

**Out of Scope:**

Testing of hardware components solar panel or powerwall. Only the effect of state of these components is required to test the energy software.

**For executing all the below tests, the build generation and install testing is a pre-requisite, and is executed in each case.**

**Build Verification Testing (BVT)**

# Tests to run on each SW build to quickly identify any issues. Should run very quickly.

**Feature: Charging-discharging with no grid power outage**

**Scenario: Solar panel supply is greater than home load**

Given:

I set solar panel supply to 2kW

I switch on ‘grid’ power supply

I set home load to 1kW

When:

I set powerwall charge at ‘9’ percent

I switch on ‘solar panel’ power supply

Then:

I check powerwall charge ‘increases’ after some time

I check home load is ‘running’

I check contactor is ‘closed’

When:

I set powerwall charge at ‘11’ percent

I switch on ‘solar panel’ power supply

Then:

I check powerwall charge ‘increases’ after some time

I check home load is ‘running’

I check contactor is ‘closed’

**Scenario: Powerwall charging only from solar panel**

Given:

I set solar panel supply to 1kW

I switch on ‘grid’ power supply

I set home load to 1kW

When:

I set powerwall charge at ‘11’ percent

I switch on ‘solar panel’ power supply

Then:

I check powerwall charge ‘does not increase’ after some time

I check home load is ‘running’

I check contactor is ‘closed’

When:

I switch off ‘solar panel’ supply

I set powerwall charge at ‘9’ percent

Then:

I check powerwall charge ‘does not increase’ after some time

I check home load is ‘running’

I check contactor is ‘closed’

When:

I set solar panel supply to 0.5kW  
I switch on ‘solar panel’ supply

Then:

I check powerwall charge ‘increases’ after some time

I check home load is ‘running’

I check contactor is ‘closed’

When:

I set solar panel supply to 2kW  
I switch on ‘solar panel’ supply

Then:

I check powerwall charge ‘increases’ after some time

I check home load is ‘running’

I check contactor is ‘closed’

**Scenario: Solar panel supply is lower than home load**

Given:

I set solar panel supply to 1kW

I switch on ‘grid’ power supply

I set home load to 2kW

I switch on ‘solar panel’ power supply

When:

I set powerwall charge at ‘50’ percent

Then:

I check powerwall charge ‘decreases’ after some time

I check home load is ‘running’

I check contactor is ‘closed’

When:

I set powerwall charge at ‘9’ percent

Then:

I check powerwall charge ‘does not decrease’ after some time

I check home load is ‘running’

I check contactor is ‘closed’

**Scenario: Powerwall charge zero percent**

Given:

I switch on ‘grid’ power supply

I set home load to 2kW

When:

I set ‘solar panel’ power supply to 3kW

I switch on ‘solar panel’ power supply

I set powerwall charge at ‘0’ percent

Then:

I check powerwall charge ‘increases’ after some time

I check home load is ‘running’

I check contactor is ‘closed’

When:

I set ‘solar panel’ power supply to 1kW

I switch on ‘solar panel’ power supply

I set powerwall charge at ‘0’ percent

Then:

I check powerwall charge ‘does not increase’ after some time

I check home load is ‘running’

I check contactor is ‘closed’

**Feature: Charging-discharging with grid power outage**

**Scenario: Solar panel supply is greater than home load**

Given:

I set solar panel supply to 2kW

I set home load to 1kW

When:

I set powerwall charge at ‘9’ percent

I switch off ‘grid’ power supply

Then:

I check contactor is ‘open’ within ‘100ms’

I check powerwall charge ‘decreases’ after some time

I check home load is ‘running’

I check contactor is ‘open’

When:

I switch on ‘grid’ power supply

I set powerwall charge at ‘11’ percent

I switch off ‘grid’ power supply

Then:

I check contactor is ‘open’ within ‘100ms’

I check powerwall charge ‘decreases’ after some time

I check home load is ‘running’

I check contactor is ‘open’

**Scenario: Solar panel load is lower than home load**

Given:

I set solar panel supply to 1kW

I set home load to 2kW

When:

I set powerwall charge at ‘9’ percent

I switch off ‘grid’ power supply

Then:

I check contactor is ‘open’ within ‘100ms’

I check powerwall charge ‘decreases’ after some time

I check home load is ‘running’

I check contactor is ‘open’

When:

I switch on ‘grid’ power supply

I set powerwall charge at ‘11’ percent

I switch off ‘grid’ power supply

Then:

I check contactor is ‘open’ within ‘100ms’

I check powerwall charge ‘decreases’ after some time

I check home load is ‘running’

I check contactor is ‘open’

**Scenario: Powerwall charge zero percent**

Given:

I switch on ‘solar panel’ power supply

I set powerwall charge is set to ‘0’ percent

When:

I switch off ‘grid’ power supply

Then:

I check home load is ‘not running’

I check contactor is ‘open’

**Feature: Grid power outage**

**Scenario: Contactor opens within 100ms of grid power outage**

Given:

I switch on ‘solar panel’ power supply

I switch on ‘grid’ power supply

I check contactor is ‘closed’

When:

I switch off ‘grid’ power supply

Then:

I check contactor is ‘open’ within ‘100ms’

**Scenario: Contactor closes when grid power comes back on**

Given:

I switch on ‘solar panel’ power supply

I switch off ‘grid’ power supply

I check contactor is ‘open’

When:

I switch on ‘grid’ power supply

Then:

I wait some time

I check contactor is ‘closed’

**Functional/Feature Verification Testing (FVT)**

# Tests to run on selected builds. This includes end to end feature testing cases and possible stress testing conditions. May take much longer to run than BVT, and also covers cases for regression.

# Cross-feature and performance testing.

# We should run FVT suite on a build only after it passes BVT suite.

**Feature: Charging-Discharging**

**Scenario: Solar panel output switching**

Given:

I switch on ‘grid’ power supply

I set powerwall charge to 90 percent

I set home load to 2kW

Then:

On sweeping solar panel power supply, I see that powerwall has following states, and the home load is always running

| solar panel supply | powerwall state |

| 1kW | discharging |

| 1.5kW | discharging |

| 1.8kW | discharging |

| 2kW | not charging or discharging |

| 2.2kW | charging |

| 1.9kW | discharging |

| 2.1kW | charging |

| 1.8kW | discharging |

| 2.2kW | charging |

**Scenario: home load switching**

Given:

I switch on ‘grid’ power supply

I set powerwall charge at 90 percent

I set solar panel power supply to 2kW

Then:

On sweeping home load, I see that powerwall has following states, and the home load is always running

| home load | powerwall state |

| 1kW | charging |

| 1.5kW | charging |

| 2.1kW | discharging |

| 2.5kW | discharging |

| 1.9kW | charging |

| 2.1kW | discharging |

| 1.8kW | charging |

| 2.2kW | discharging |

**Scenario: Solar panel output and home load switching**

# this is a concurrency test to make sure that the software responds to both supply and load transients

Given:

I switch on ‘grid’ power supply

Then:

On sweeping the solar panel supply and home load, I see that powerwall and home load is always running

| solar panel supply | home load | powerwall state |

| 3kW | 1kW | charging |

| 2.5kW | 1.5kW | charging |

| 2kW | 2kW | not charging or discharging |

| 1.5kW | 2.5kW | discharging |

| 1kW | 3kW | discharging |

| 1.5kW | 2.5kW | discharging |

| 2kW | 2kW | not charging or discharging |

**Feature: Grid power switching**

**Scenario: Grid power supply switching on and off**

# for this scenario, grid power supply output is constant

Given:

I set home load to 2kW

I set powerwall charge to 90 percent

Then:

On switching the grid power supply and solar panel supply, I see the following powerwall and contactor states, and home load is always running

| grid power supply | solar panel supply | powerwall state | contactor state |  
| on | 2.5kW | charging | closed |

| off | 2.5kW | discharging | open |

| on | 2.5kW | charging | closed |

| off | 2.5kW | discharging | open |

| on | 1.5W | discharging | closed |

| off | 1.5kW | discharging | open |

| on | 1.5kW | discharging | closed |

| off | 1.5kW | discharging | open |

**Scenario: Grid power supply droops**

# grid supply is meant to be constant and ideal but sometimes its not, which may cause unexpected things to happen. For this scenario, grid power supply output is not constant, and the value can be considered as max output power the grid can supply at a given point.

Given:

I set home load to 2kW

I set powerwall charge to 90 percent

Then:

On switching the grid power supply and solar panel supply, I see the following powerwall and contactor states, and home load is always running

| grid power supply | solar panel supply | powerwall state | contactor state |  
| 4kW | 2.5kW | charging | closed |

| 3kW | 2.5kW | charging | closed |

| 2kW | 2.5kW | charging | closed |

| 1.5kW | 2.5kW | discharging | open |

| 1.9kW | 1.5kW | discharging | open |

| 2.5kW | 1.5kW | charging | closed |