Critical Systems (CSCM13) Coursework Program Specification for

Power Grid Energy Stabilizer Setzer System

By Timur Ozkul #999072

Overview

The Power Grid Energy Stabilizer Setzer System is a program that is utilized by the renewable energy companies to stabilize their energy grid. It's critical that the grid is stable in order to give a constant influx of electricity to the buildings since some of the organizations need constant electricity to operate. This makes it a safety-critical system, and failure or malfunction may result in death or serious injury to people, loss or severe damage to equipment/property, environmental harm. The number one objective is to always have the energy to supply the demand. Since this program is for renewable source energy, it can be that in a given day that there might not be enough energy. Hence alternative sources need to exist and be immediately accessible. Users will be able to make their own decision at certain points to decide when to buy energy from the non-renewable energy companies. This system is designed so it is fail-safe, meaning that at any point in time, that consumption of electricity can never be greater than the supply of energy. The system automatically buys energy from the non-renewable energy companies when supply isn't enough. The system gives status to help them make well-informed decisions. The refill system is partly automated. Wherever supply exceeds the consumption, then if the batteries are not at the maximum capacity already, they will be refilled with the remaining supply. If the batteries are at a critical level, the user is given the option to buy electricity from non-renewable energy companies. The sbattery is allowed to reach 0, but then whenever extra energy is required, the automatic purchase from non-renewable energy companies takes place. Since the company's objectives beyond the safety of the people are the safety of the environment, it's important to minimize the purchase from non-renewable energy companies. This is a challenging task to be able to provide safety to people always and, at the same time, minimize the impact on the environment.

The average home consumes about 11 kW per day, which makes it 0.13 watts per second, and in GW it's 0.000011. The power grid system has the capacity to supply over 3.2 million homes. The average energy consumption of 416,000 watts (416 kW) per second. The grid's maximum energy capacity is at 10,000 kW per second. The global variable for maximum capacity is set to 10,000 kW (*Maximum_Electricity_Possible*).

System initialization

The System's first procedure to be executed is the ‘Init’, which initializes the global variables that are used throughout the system and the initialization of the Input/Output library. This procedure is only executed during the initialization of the system itself. Once the system has initialized and has executed the *Init* along with the *Print_Welcome* procedure that just prints a welcome message, it starts the loop that runs the rest of the system.

Loop Invariant

At the start of the main loop that runs the system there loop invariant a loop invariant. That proves the properties of the loop and is a formal program verification. Once the program reaches the loop invariant, it checks two conditions that must hold true at the beginning of each iteration. The condition is that the consumption is less or equal to the supply else the system would fail. The second one is that the status of the battery reserve needs to be not active. At the end of every iteration, the status of the battery needs to be reset since the battery is not being used. These conditions then correspond with the post and preconditions in the *Energy_Stabilizerg_System* and *Refill_Reserve.* The Energy_Stabilizerg_System makes sure that the consumption never reaches a level higher than the supply. The *Refill_Reserve* is the procedure to be executed and resets the battery status.

Measurement Inputs

In the program, there are several points where the user gives input. The first two inputs are the reading of the electrical measurements. After the loop invariant checks the condition, the next two procedures that get executed are the *Read_Consumption* and the *Read_Supply*. The Read_Consumption asks the user for the input of the current consumption level of electricity. Checks whether the input is a valid input by checking if it's in the electrical range by comparing it to the global variable *Electricity_Range*. Once validated, it stores the value in the global variable *Status_System_Type.Consumption_Measured*. The *Read_Supply* asks the user for the input of the current supply level of electricity. The verification of the range and storage of the variable is the same, except it stores the value in *Status_System_Type.Supplied_Measured.*

Main logic

The main logic of the system lies in *the Energy_Stabilizerg_System* procedure. This procedure is what stabilizes the system to make sure the consumption never exceeds the supply. If the system doesn't have enough supply through its main source of renewable energy, it falls back to possibilities. The first that gets executed is that the battery reserves are used. If in the case, the batteries are enough to meet demand, then the last possibility is used, which is the purchase of electricity from non-renewable energy companies. This process is automated in order to make the system fail-safe. So humans can't interfere and somehow disallow the part of the process. Global variables are read from to get the readings in the procedure and to check the battery levels. Within the logic, new supply and the battery levels are adjusted in the global variables. The battery status is updated to active, in addition to an informative print out saying that the system is at a critical level and that automatic purchase will take place.

System Status

After executing the main logic of the system, the system status is printed out. In the *Print_Status* procedure, global variables are only read from. It prints the status of energy consumption, supply, battery reserve, and battery status. If the batteries are at a critical level, which is pegged at 50,000 watts (with maximum capacity to store up to 1,000 kW), then it gives a warning. In addition to informing on how much the battery will be refilled if there is supply left over.

Final Execution

The final procedure that gets executed is *Refill_Reserve.* This procedure refills the battery reserve or gives the option to do so. If there is remaining supply after consumption and there is space to fill the energy reserves, the battery gets refilled with that supply here. Thereafter the procedure checks if the battery reserve energy levels are below the critical level; if they are, it asks the user to make a decision. It informs the user that the battery reserves are below the critical level and asks him if he wants to purchase from a non-renewable energy company. If the user chooses to do so, then the battery levels are put back above critical.