Energy Game Specification Document

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# Overview

The ‘Energy Game’ application is a game built on the Unity platform. It focuses on simulating the power system in a household and allowing the player to slowly relace the households power grid connection with renewable power production methods. This includes modelling the power production of several energy generation methods, the power consumption of several energy consumers, and the infrastructure require to operate them.

# Purpose

The purpose of this application is to provide a platform for education and learning about renewable energy in the home, specifically with regards to the context of a single household. The application should allow users to become familiar with how to balance energy generation and power consumption, as well as how batteries and charge controllers effect this.

# Glossary

|  |  |  |
| --- | --- | --- |
| **Term** | **Definition** | **Additional Information** |
| IRL | Abbreviation of ‘In Real Life’ |  |
| XP | Abbreviation of ‘eXperience Points’ |  |
| kw | Abbreviation of ‘Killo Watt’ |  |
| Power sink | Anything that consumes power permanantly. |  |
|  |  |  |

# Current state

## Power Generation Methods

### Solar Panels

Solar panels can be placed freely on the roof of the house until there is no more room for them. Solar panels generate power based on the solar radiation available according to the Weather API data. Solar panels cost $500 each and have an ongoing maintenance cost of $40. Solar panels provide 50 XP per unit to the player.

### Wind Turbines

A single wind turbine may be added in a set location in the corner of the property. The wind turbine will generate 0.4kw continuously. The wind turbine costs $10,000 and has no ongoing maintenance cost. The player receives no XP for buying a wind turbine.

### Diesel Generator

A single diesel generator can be placed in a single location next to the house. The generator will produce up to 22 kw continuously for as long as it has fuel, which it will burn at a rate dependant of the amount of power being generated. The diesel generator costs $10,000 and has no ongoing maintenance cost other than the cost of fuel used. The player receives no XP for buying the diesel generator. The generator holds 60 units of fuel.

### Power Grid Connection

A power pole may be placed in a single location in the corner of the map allowing for a connection to the power grid. The power grid has a continuous capacity of 22kw and will provide power indefinitely. The grid connection costs $12,000 to buy and has no ongoing maintenance costs. The player receives no XP for buying the grid connection.

## Power Sinks

### Air conditioner

There are 3 sizes of air conditioner available to purchase. Each air conditioner can be purchased once and will each be placed in a different set room in the house. The 3 air conditioners cost $1,000, $1,500, and $2,000; and consume a constant 2kw, 3kw, and 4kw respectively. None of the air conditioners have an ongoing maintenance cost. All 3 air conditioners provide 30 XP when purchased.

### Washing Machine

There are 2 sizes of washing machine available to purchase. Each washing machine can be purchased once and will be placed side by side in the same room of the house. The 2 washing machines cost $400 and $750; and consume a constant 0.3kw and 0.6kw respectively. Neither of the washing machines have any ongoing maintenance costs, nor do they provide any XP when bought.

### Light

There are 4 ceiling lights that can be purchased, one for each room of the house. Each light is functionally identical with:

* a cost of $100
* a constant consumption of 0.025kw
* no ongoing maintenance costs
* no XP awarded when purchased.

### Refrigerator

There are 2 refrigerators available for purchase. Each refrigerator can be bought once and will be place together in one of the rooms of the house. The refrigerators will cost $500 and $1000; and consume a constant 0.7kw and 1kw respectively. Neither refrigerator will require any ongoing maintenance costs nor will either provide any XP when bought.

### Ceiling Fan

There are 3 ceiling fans available for purchase. Each fan can be purchased one and placed inside one of 3 of the houses 4 rooms. The fans cost $200, $300, and $500; and consume a constant 0.06kw, 0.08kw, and 0.1kw respectively. None of the fans have any ongoing maintenance costs nor do any of them provide any XP when bought.

## Supporting Infrastructure

### Batteries

Batteries can be purchased once and will be placed on one of the exterior walls of the house alongside the charge controller, inverter, and power meter. The batteries cost $8000 and can provide up to 9kw continuously for as long as its stored power lasts. The batteries do not have any ongoing maintenance costs and they provide 90 XP when purchased. The maximum amount of power that can be stored in the batteries is 25kw. The batteries will not operate without an inverter, charge controller, and some form of power generation (Neither grid power nor the diesel generator will charge batteries).

### Inverters

An inverter can be purchased once and will be placed on one of the exterior walls of the house alongside the charge controller, batteries, and power meter. An inverter costs $1000 and does not directly provide nor consume power. The inverter does not have any ongoing maintenance costs and provides 60 XP when purchased.

### Charge Controllers

A charge controller can be purchased once and will be placed on one of the exterior walls of the house alongside the inverter, batteries, and power meter. A charge controller costs $2000 and does not directly provide nor consume power. The charge controller does not have any ongoing maintenance costs and provides 130 XP when purchased.

# Functional Specification

## Core Gameplay Loop

Balancing power generation and consumption. Is underdeveloped.

## Timescale

The Current timescale for the game uses a simple IRL second to in game minute mapping that defaults to 1:1 but can be freely changed in increments of 5 e.g.1:1 🡪 1:5 🡪 1:10 🡪 1:5 between the minimum of 1:1 and the maximum of 1:60 with these corresponding to 1 IRL second is 1 in game minute and 1 IRL second is 1 in game hour respectively.

## Economy

### Power

The power economy is the balancing act of managing the available power (Output Rate) to the house and the consumption (Load Rate) of the house’s appliances. Generally, this will mean ensuring potential power generation always exceeds power consumption, however the use of batteries to store excess power can allow a less strict regime to be implemented. Power in nominally given in kw/kwh.

Carbon offset TBC

### Money

Money is used to make purchases for both power generators and consumers. As it currently stands there is no way to increase money in game. Other than no longer being able to make purchases there does not seem to be any consequence for running out of money.

## End Conditions

### Victory Conditions

None.

### Loss Conditions

None.

## Functional Requirements

* The game must allow players to select the component for placement
* The game must allow players to purchase the component if they confirm the placement
* The game must allow players to purchase the component if they confirm the placement
* The game must allow players to cancel after selecting a component to purchase
* The game must decrease the players money upon purchasing components
* The game must allow players to select existing components for removal
* The game must allow players to sell an existing component if they confirm the removal
* The game must allow players to cancel after selecting an existing component for removal
* The game must increase the players money by half of the components purchase cost upon selling components
* The game must provide users the option of purchasing different size appliances
* The game must allow players to turn on/off energy system components
* The game must allow players to turn on/off appliances
* The game must show the details of a component if it is selected
* The game must show the total household output and load
* The game must show the total emissions produced for each non-renewable energy system component
* The game must show the total emissions offset for each RE system component
* The game must show the total household emissions and offset
* The game must notify players when the energy system is running
* The game must notify players when the energy system is overloaded
* The game must show real-life weather data such as temperature, solar radiation and wind speed
* The game must show the in-game date and time
* The game must allow players to increase/decrease the rate of time in-game

## Technical Requirements

* The game must be smooth by providing players with a maximum input response time of 1 second
* The game must be highly available with a downtime of 1% (3.65 days/year)
* The games access to weather data must be highly available with a downtime of 1% (3.65 days/year)
* No more than 1 per 10000 inputs by the player shall result in a failure requiring the game to be restarted
* The game defect rate shall be less than 1 failure per 100 hours of playtime
* The games access to weather data must utilise Hypertext Transfer Protocol (HTTP)
* The games user interfaces (UI) must follow a consistent theme
* The game must not overwhelm the player with large amounts of complex information
* The game must be designed with consideration for future improvements and features

## Test cases

User or Unit/Integration?

# Technical Specification

## Weather API Specification

## Faults

## Power Generation

## Power consumption

## Core Logic Breakdown

## Underlying Databases

# Planned Work

## Bugs to Log

* There is no indication of what the current timescale is in game other than the size of the ticks themselves.
* If weather data is not available, the default solar generation seems to be 0kw.
* Inconsistency between kw and kwh
* Charge controller Model not showing correctly.
* Purchasing multiple of a single purchase only item will award XP each time despite the sale not occurring.
* Adding generators does not drag the camera to the right location.
* Bedroom doorway is unreasonably small.
* The bedroom fan does not appear when bought.
* The temperature displayed on screen is confusing due to a lack of units(c, f).
* Failing tests.

## Planned Enhancements

* Better solar generation model
* Better wind generation model
* Wear for solar
  + Weather damage
  + Cleaning required
* Wear for wind
* Faults for solar (Look into batteries)
  + Charge controller dying
* Faults for wind