

Project 2 Jamie Serlin Document

AC1 Informing Ideas

Response to Brief

The Brief has asked me for a digital animation, game or experience that promotes energy conservation and the awareness of energy consumption. It is for all/any ages, and must be completed in a game engine such as Unity or Unreal.

While I have experience in both Unity and Unreal, I will be using Unity 3D for this project, as I personally prefer C#, as opposed to Unreal's Blueprint system or C++. It also provides a lot more tools for lo-poly models as it has a lot more downloadable packs on the Unity Asset Store.

My initial idea was a tycoon/builder game which encourages learning statistics and facts about green energy solutions such as wind turbines, and needs strategic thinking to place energy sources in the correct position. This will allow my game to satisfy older demographics, as it requires strategic thinking and tactics.

E.ON Research

Facts about climate change

- <https://climate-change.data.gov.uk/>
- The average temperature in the UK has increased by 1 degree centigrade since 1980
- The use of carbon-based fuels has gone down from 215.86 Mtoe to 134.84 Mtoe since 1990

What has E.ON been doing to help?

- <https://www.eonenergy.com/sustainable-businesses.html>
- <https://www.eon.com/en/business-customers/success-stories/marks-spencer.html>
- They have started using their Building energy Management Systems (BeMS) and Heating Ventilation & Air Conditioning (HVAC) systems. This reduced M&S' energy consumption by 34%.

E.ON has also been attempting to decrease energy usage in homes. They sell solar panels to home-owners as well as businesses, and teach people about ways to decrease your energy usage in a smart way (I.E. using insulation,

energy efficient boilers.)

They also provide a supply of 100% renewable electricity through E.ON Next, for businesses as well as homes.

E.ON specifically are supplying EV charging solutions, to help increase the usage of electric vehicles. They are also partnering with Nissan to invest in V2G, which allows energy to be transferred to nearby buildings from EV batteries.

Some more facts about green energy

- 1 Wind Turbine is able to produce over 843,000 kWh per month of energy, enough for over 940 average US homes.
- <https://www.usgs.gov/faqs/how-many-homes-can-average-wind-turbine-power#:~:text=At%20a%2042%25%20capacity%20factor,than%20940%20average%20U.S.%20homes>
- The average single solar panel outputs 170-350 watts every hour, assuming 5 hours of direct sunlight. This works out to about 0.17 kWh to 0.35 kWh per solar panel.
- <https://news.energysage.com/what-is-the-power-output-of-a-solar-panel/#:~:text=The%20average%20solar%20panel%20produces,0.35%20kWh%20per%20solar%20panel>

Game Research

- Factorio

Factorio

is a sandbox game in which you build massive factories using conveyor belts and automated technology. The main progression is a very large tech tree of more and more complicated automation features, such as conveyor splitters, insertion arms, worker robots, logistic robots, etc.

Clean energy comes into play when you have a large enough factory. Large factories create a lot of pollution around the area, and this is visually represented by green water, dust clouds, and different ground textures.

Pollution is an important mechanic as well, as it attracts enemies such as Biters and Spitters which will attempt to destroy the largest source of pollution nearby. This means that you need to create automated defense systems in the form of protective walls, and turrets that need to stay fed with ammunition.

This adds to the game as there is an extra layer of thought added to your factory expansion, and the threat of enemies is always looming.

- Cities Skylines

Cities: Skylines

is a sandbox game about building your own city, similar to SimCity and Tropico. However, it also makes you manage infrastructure such as energy, waste disposal and water pipes.

Citizens will become unhappy if they are placed too close to an industrial zone, or if they have no access to basic services. There is also a negative penalty for using fossil fuel power stations instead of green solutions.

Waste that is dumped into the water will pollute it, and make citizens unhappy. All of this combines to make a game where clean, green energy is extremely important and it teaches players about many negative aspects of fossil fuels and unsustainable energy management.

I enjoyed this game as there were a lot of things to think about while building your city, and there were a lot of well designed mechanics. It also allowed a lot of player expression as you could shape the city yourself using roads and zone different areas (Commercial, Industrial and Residential).

- Terra Nil

Terra Nil

is a puzzle game set in the near future, where you are tasked with making earth back into a habitable environment after it has been destroyed by harvesting energy. You do this by placing structures that add life back to the world, such as irrigation and climate control tech. There is also a mechanic of biodiversity, so you need to have an equal amount of different biomes to keep the animals alive. At the end of the game, you need to pack up all of your structures and leave the planet. This is easier said than done as you need to use monorail connections and drones in order to do this.

I enjoyed this game, however there was a lot going on and the tutorial was quite condensed and taught you a lot very quickly.

While it's a fun puzzle game, i think it may have too many mechanics and different things to think about. it can get confusing pretty quick. There were also some redundant features that didn't add to the gameplay much, such as the stored energy mechanic. It is meant to limit how many objects you can place down, but there are already mechanics to do that, and it didn't add much to the game as a whole.

My favorite part was the graphics. It used a large contrast between the environment to show where life was flourishing, and where it was still dead and barren.

- Green with Energy

Green with Energy

is a puzzle game in which you need to supply houses with energy using green solutions such as wind turbines and solar panels. You need to think about different voltages, and the day-night cycle of energy.

For example, solar panels aren't enough to power a house alone, as during the night they don't give off any power. To fix this, you would need to add a battery plant that can store power and give it off when needed. You also need to transform high-voltage into low-voltage before connecting power to a house.

It also rewards efficiency in your plans as you have a budget and everything you place costs money.

The full game isn't out yet, however it's promising and could be a fun puzzle game. I did notice a few bugs / unfinished features which is normal for a pre-release demo.

AC2 Problem Solving

To begin, I generated some ideas that take inspiration from the games I researched in the [AC1 Informing Ideas](#). I wanted to take the parts of each game that I enjoyed, while trying to fix the issues I had with them.

Game Ideas

Idea 1:

- Sandbox game, similar to Factorio.
- Auto-building city every interval, increasing energy demands and game difficulty
- You need to build energy infrastructure and plants in order to supply energy around the city.
- Meanwhile keeping the inner city non-polluted and green.
- Difficulty of the game will be trying to keep energy demand satisfied, while keeping infrastructure and energy-creating structures away from the center of the city.

Idea 2:

- simple tile-based building game in which you create a power grid
- increasing energy demands over time

- playing within a space constraint that expands by selling excess energy for money
- Each tile has a unique statistic for price, wind speed and sunlight hours. This means you need to strategize and find the perfect place for building each structure / wire.

Idea 3:

- Nuclear Reactor Simulator
- Model of a nuclear reactor, in which you have to keep the reactor in a power-generating state.
- Helps teach about the operation of nuclear reactors and how they work on a technical level.

Evaluation

Game 1 was interesting, although I think it would take much longer to create. It also needs to take into account many statistics, such as population happiness, energy output, and money. I feel it would get hard to visualise these statistics, especially population happiness. I would also have to figure out how to auto-build the city, which I think may get confusing as players might not understand what is happening. Game 3 was a good idea, however as I started researching it, it became obvious that it would be much more complicated than I was originally thinking of. There are lots of complex mechanics and relationships between variables, and I haven't been able to find a very good resource to learn exactly what all these rules are. I chose to pursue Game 2, as it seems like a more simple version of Game 1. It has good potential as an endless game, as the map can keep expanding, and a fair bit of strategy as you need to select the optimal location for every tile.

Game Design Document

Overview/Pitch

Energy is an Isometric, tile-based strategy game in which you have to adapt to an increasing energy demand by building green energy solutions and searching the environment.

Mechanics

You begin with a 16x16 grid, with different wind speeds, daylight hours, and geothermal readings. You have to find the perfect place to locate each structure to make the most energy possible.

You have a base energy demand that you must meet, and any additional energy created can be exported for money.

Money allows you to increase the map size, in order to find new tiles to build on.

Structures

Since the game needs to be endless, energy accumulates over time depending on how many structures you have built. Therefore, the game is not able to be lost, as you will always have some kind of energy generation. However the speed of expansion is based on how well you place your tiles and how optimally you have structured your energy plant.

Examples

Wind Turbines - 200 MWh *Tile's Wind Speed*

Solar Panels - 100MWh *Tiles's Daylight Hours*

Map

I have decided that random generation will be a good fit for this game. This is because it increases replay value as the map is different each time, as well as adding a random element that spices the game up. The world will be made up of tiles in a grid system, each with their own wind speeds and daylight hours, as well as building cost. You will be able to toggle different information overlays through the UI. These stats will influence the amount of power that any structure on that tile will output.

Camera

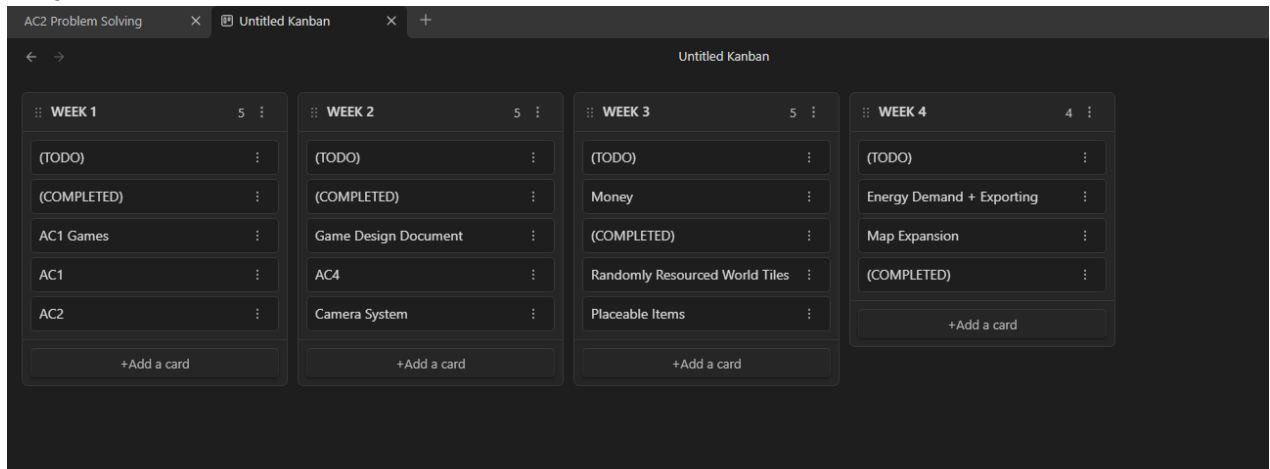
I will use a 3D Isometric view for this game, as it mimicks other factory/building games I have researched.

Visual Style

Since it will be a 3D game, I need a relatively fast and convenient way to create models for the game. If I went for realism, I would probably take lots of time that I could spend on more important things. Therefore, I will go with low-poly modelling.

AC4 Evaluation

In order to plan my project, i used a Trello board. This is a good strategy, as they let you add extra detail to the cards and very visually see how far you are along the project.



I broke down every mechanic that I needed to complete based on the Game Design Document. Then, I started rationing out the tasks over the 4 weeks I had, including the writing tasks.

This was extremely helpful as it helped me know exactly what I needed to do at every time, and my work was spread evenly over the whole time I had.

Technical Skill

In order to make my structure building game, i needed to learn some skills. I used a mix of written tutorials and youtube videos to learn various systems such as a grid system, and placing mechanics.

First was the grid system. Luckily, i found a very useful tutorial series by Code Monkey on Youtube. This helped me to get the grid working, and I also made a few tweaks such as a cursor that could have a reference to an individual cell.

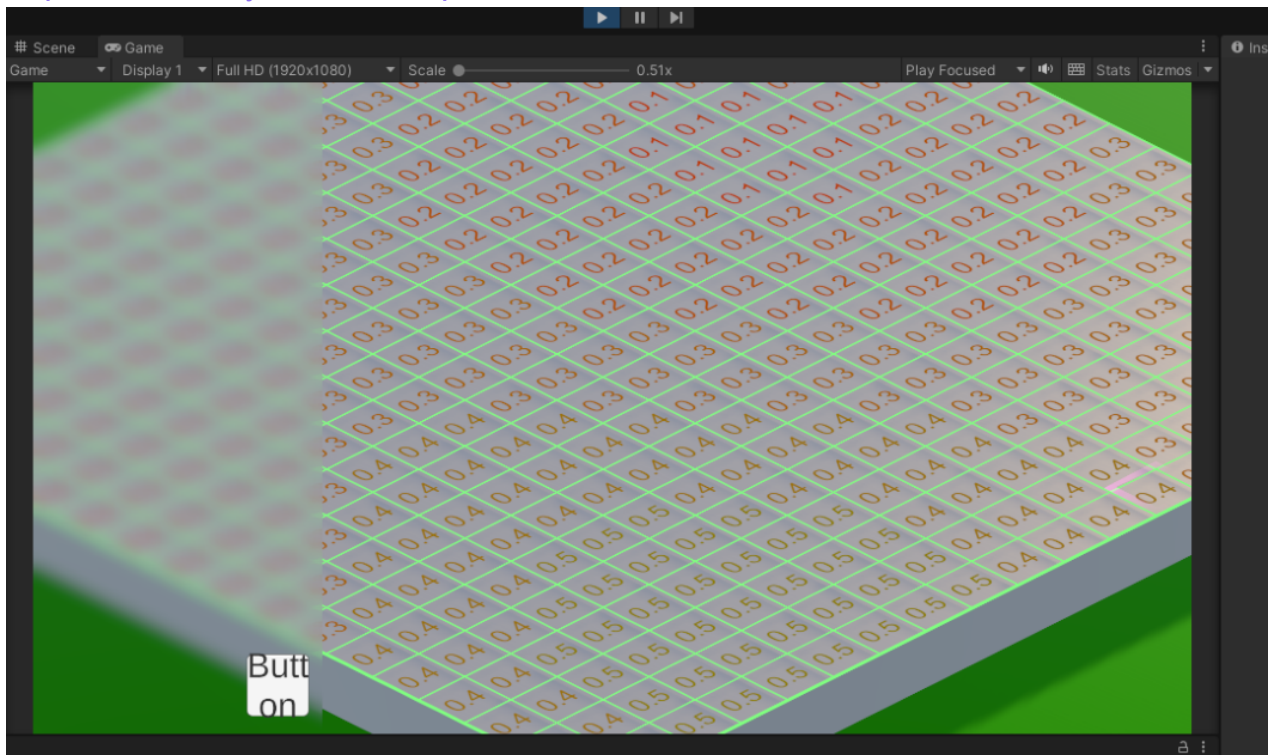
<https://www.youtube.com/watch?v=waEsGu-9P8&list=PLzDRvYVwl53uhO8yhqxcyjDImRjO9W722>

The generation of the map was also quite difficult. I opted to use a generation technique called Perlin Noise, which put each tile through a function in order to create a semi-random, yet still coherent noise.

The noise does not contain a completely random value at each point, but rather consists of "waves" whose values gradually increase and decrease across the pattern.



<https://docs.unity3d.com/ScriptReference/Mathf.PerlinNoise.html>



I also added multiple layers of perlin noise. This was so that the Wind stat, the Daylight stat, and the Cost stat are all different.

This was quite difficult to implement, as I had to learn how the `Mathf.PerlinNoise()` function worked. My finished code for this looks like:

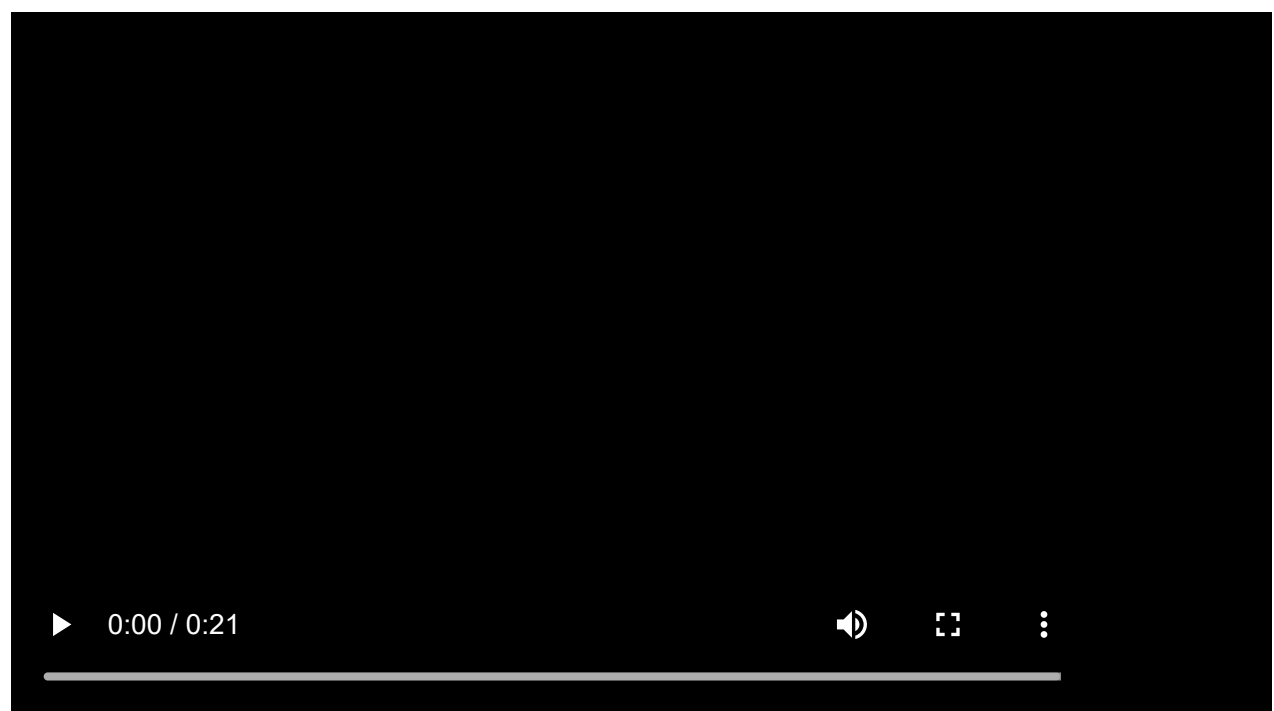
```
//for each tile, upon creation, this code runs
//offset is used so that each generation is different, and each of the 3
stats are
//different as well
int offset1 = Random.Range(0, 256);
//x and y are the current location of the tile being run through this
float x1 = (float)x / gridArray.GetLength(0);
float y1 = (float)y / gridArray.GetLength(1);
```



```
float n1 = Mathf.PerlinNoise(x1 * 2 + offset1, y1 * 2 + offset1);  
c.buildCost = n1;
```

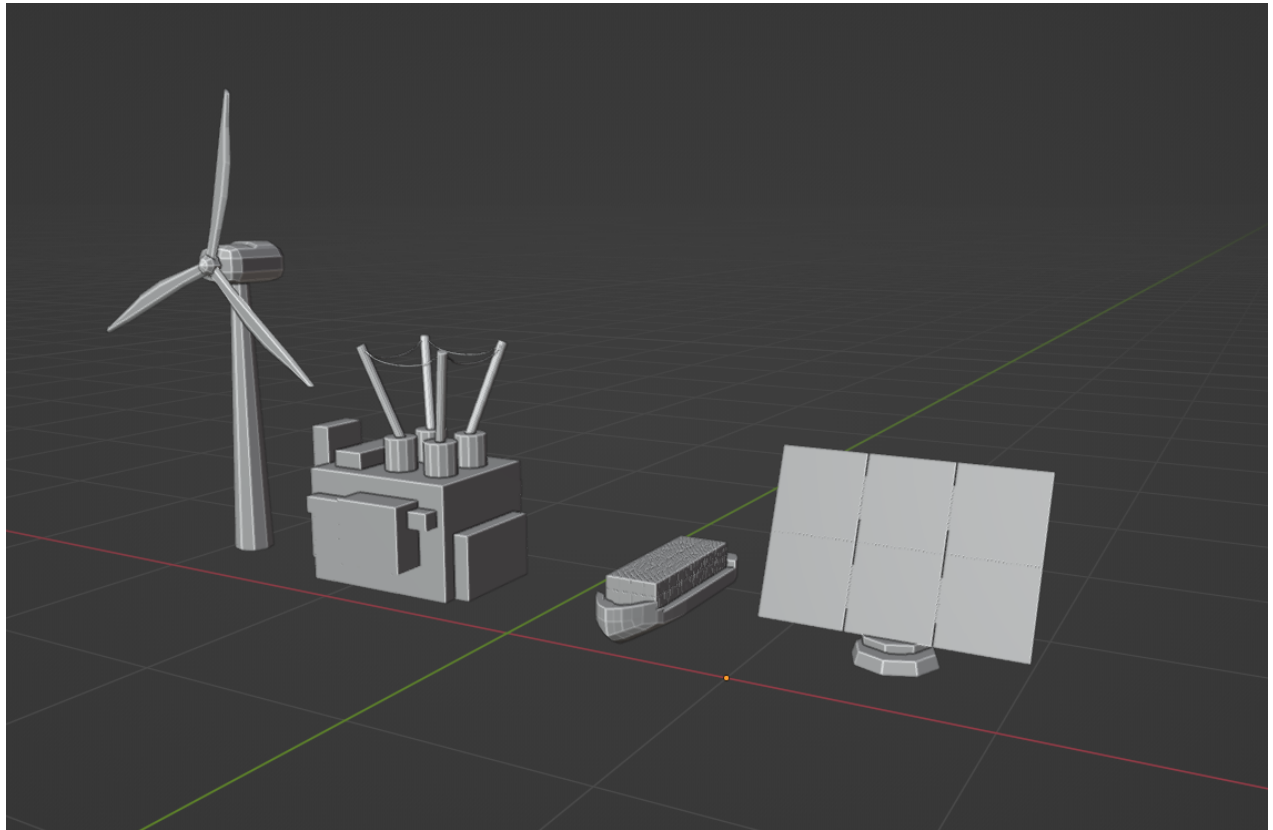
Of course i had to copy this 2 more times, as I started with 3 statistics per tile. Then, I had to add buttons to change which stat was visualised, as well as altering the colour of the underlying tile to make it easier to parse.

```
public void ChangeInfoOverlay(float info)  
{  
    //Change the text of the tile to a truncated version of  
    the stat  
    //the real statistic has around 8 decimal places, so we  
    need to simplify it  
    //for readability  
    this.info.text = info.ToString().Substring(0, 3);  
    this.info.color = Color.white;  
    this.info.fontStyle = FontStyle.Bold;  
  
    //Smoothly blend between start and end colour (green and  
    red) depending on  
    //the "info" float (the stat)  
    Color32 start = new(0, 255, 0, 255);  
    Color32 end = new(255, 0, 0, 255);  
    cube.material.color = Color.Lerp(start, end, info);  
}
```



For visual interest, I also 3D Modelled my own props.

This was fairly simple, as I'm used to working in blender. I decided to use lo-poly as it creates quite a nice, simple vibe and was much less time-consuming than creating realistic assets. I even made an animation for the wind turbine, to make it spin around when placed.



Grid System

I had to create a grid system to base my game off. This meant a Cell object in each grid space, which could store information such as the current structure on that cell, its place in relation to others, and the Wind Speed/Daylight Hours/Cost.

Here is some code i wrote for the line renderer, the part that displays green lines on the edge of every grid cell.

```
{  
    //set up grid materials + size  
    gridMat = new(Shader.Find("Unlit/Color"));  
    gridMat.color = new Color32(128, 255, 128, 255);  
    int xLength = gridArray.GetLength(0);  
    int yLength = gridArray.GetLength(1);  
    Vector3[] pos = new Vector3[2];  
    //Start drawing lines horizontally  
    for (int x = 0; x < yLength; x++)  
    {  
        pos[0] = new(0, 0, x);  
        pos[1] = new(xLength, 0, x);  
    }  
}
```

```

        AddLineRenderer(pos);
    }
    //Start drawing lines vertically
    for (int y = 0; y < xLength; y++)
    {
        pos[0] = new(y, 0, 0);
        pos[1] = new(y, 0, yLength);
        AddLineRenderer(pos);
    }
    //Complete outside Square
    pos[0] = new(0, 0, yLength);
    pos[1] = new(xLength, 0, yLength);
    AddLineRenderer(pos);
    pos[0] = new(xLength, 0, 0);
    pos[1] = new(xLength, 0, yLength);
    AddLineRenderer(pos);
    return;
}

```

