Material

Monday, February 5, 2024   6:51 PM

Required Submissions

- Code
- Slides containing:
  - Participant Introductions
  - Problem Statement
  - High-Level Solution
  - Coding Languages
  - Solution Architecture
  - Cost of Implementation
  - Energy Content Supported (CCUS, Solar, Wind, Carbon Offsets, etc.)
  - Content Sources
  - Challenges/Impediments
  - Key Learnings
  - Future Steps/Improvements
- Video Presentation (5-15 min)
  - Preset Slides and Demo of Product

Grading Criteria

- **Complexity**: The level of sophistication and intricacy of the project or solution. It considers the number of components, their interactions, and the overall design of the system.
- **Feasibility**: The likelihood that the project or solution can be successfully implemented and sustained. It considers factors such as the availability of resources, the level of technical expertise required, and the potential barriers to adoption.
- **Functionality**: Should be functional and demonstrate a clear understanding of the target challenge and the applied technological solution.
- **Innovation**: Should be original, either a unique idea or has a creative take on an existing solution. It should also make use of provided resources or multiple technologies.
- **Impact**: Should be well-thought-out and effectively address the target challenge.
- **Presentation**: The presentation should be clear and the team should be able to explain their work and how they arrived at their solution. There should also be evidence of teamwork and integration.
- **Chevron/Energy Content**: Should incorporate all technologies prioritized by Chevron New Energies. The Content should be correct, abundant, and thorough. All sources cited.

Chevron New Energies

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Carbon Capture, Utilization, Storage (CCUS)

Carbon capture, utilization, and storage (CCUS) is a critical enabler of global net zero and our commitment to accelerate progress toward the lower carbon ambitions of our customers and company.

Chevron has decades of operational experience and a proven track record of carbon-capture projects and is already deploying CCUS technologies in locations across the globe. We're taking action by deploying CCUS to lower the carbon intensity of our existing assets and growing our CCUS business to help reduce emissions of the essential industries that enable modern society. We are leveraging our expertise and global reach to advance CCUS technologies and scaling viable lower carbon solutions across the value chain (capture, transport, utilization, and storage) with a focus on hard-to-abate, energy-intensive industries such as refining, petrochemicals, power, steel, and cement.

We operate Gorgon, one of the world's largest integrated CCS projects. Since the system started up in mid-2019, almost 7 million tonnes of CO_2 emissions have been injected as of 2022. We are investing in emerging CCUS technologies to bring early insights through pilot programs – often using Chevron's existing assets – and to accelerate the commercialization of promising technologies. To achieve our ambitions, we are also exploring hub opportunities in the United States and abroad.

PROS:
- Enhanced Rock Weathering (ERW)
- Job creation
- Reduced carbon emissions

CONS:
- EXPENSIVE
- Very energy intensive (almost cancels out reduced emissions)
- Environmental risk (leakage or seepage into groundwater/atmosphere)

BEST USED FOR:
- Back-up energy source for other renewables

Hydrogen

Chevron believes in the value of delivering large-scale hydrogen solutions that support a lower carbon world. We aim to deliver lower carbon energy to a growing world by creating a profitable, large-scale, lower carbon hydrogen business that builds on our existing assets, capabilities, and customers. We're well positioned to participate across the value chain to supply industrial, power and heavy-duty transportation customers.

Chevron currently produces approximately 1 million tonnes per year of hydrogen through our traditional business and has experience in retail hydrogen going back to 2005. Chevron holds more than 75 patents from early commercial ventures that are applicable to our future development plans. We produce approximately 1 million tonnes of hydrogen per year for use in our refining operations. Further, we have the potential to supply and sell hydrogen to customers from our existing refineries by leveraging our distribution capabilities, sales channels and brands. We are currently building hydrogen fueling stations at select locations.

We're exploring profitable opportunities for growth across the value chain, from upstream production through distribution into transportation, power generation and other industrial sectors. We are also evaluating using hydrogen as an alternative for industries dependent on combustible fuels and assessing development of hydrogen production hubs. And, we are leveraging our capabilities in carbon capture, utilization, and storage to unlock market opportunities for hydrogen solutions.

PROS:

- Chevron owns over 75 Hydrogen tech patents
- Already produce 1 million tons/yr.
- Existing distribution capabilities
- Abundant
- Uses more energy-efficient motors than gas

CONS:
- Research in hydrogen power is needed
- Poor power output
- Hard to store
- EXPENSIVE
- 96% of Hydrogen acquired today still pollutes
- Less energy efficient than battery-powered motors

BEST USED FOR:
- Public transport
- Heavy and long trips with few recharges

Carbon Offsets

Carbon offsets are expected to play an important role in global carbon reductions, especially in sectors that do not have cost-effective reduction opportunities or for activities where emissions are harder to abate.

Chevron's experience in developing and using carbon offsets dates back nearly two decades. We have a global carbon trading organization and actively invest in scalable, nature-based solutions – like soil carbon storage, reforestation, and mangrove restoration – to build a portfolio of high-quality credits.

We are growing a carbon offsets business to help achieve our net zero ambitions, and we are working to provide verified, low-cost, high-integrity offsets to our customers around the world to help them achieve their own lower carbon goals. As global demand grows, we expect to be a supplier of offsets by providing customers with offset-paired products. Carbon offsets are available now for use, and they can also be integrated with other lower-carbon solutions to help maximize efficiency.

PROS:
- Reduce impacts of processes that have high emissions
- Wide variety of solutions
- Immediately accessible to anyone

CONS:
- Promotes non-green energies
- High-integrity is essential
- Greenwashing
- Not an end-all solution

BEST USED FOR:
- Emission-intensive processes that cannot be changed
  - Plane rides
  - Mining
  - Steel and Cement
- As a sort of tax or reward system
- Currency?

Emerging Technologies

Chevron has a long history of identifying and driving innovation through investments in emerging technologies,

research and development, and university partnerships.

We are currently exploring opportunities to commercialize the next generation of emerging technologies. Initially, we are leveraging core capabilities in subsurface, drilling, wells and facilities, and our operating history in geothermal, to advance and scale novel geothermal energy, which can potentially allow access to a widespread baseload, nonintermittent resource that can complement and add capacity to meet the world's growing renewable-power demand. In addition to geothermal, we are exploring other emerging lower carbon power technologies, such as lithium extraction. Technologies such as long-duration storage or small, modular nuclear reactors can be part of the solutions needed to deliver on the world's growing demand for lower carbon energy. Through venture capital, we continue to invest in other lower carbon technologies.

PROS:
- Innovative solutions
- Room for growth and improvement
- Lots of money invested in this already

CONS:
- Unreliable/Unpredictable byproducts
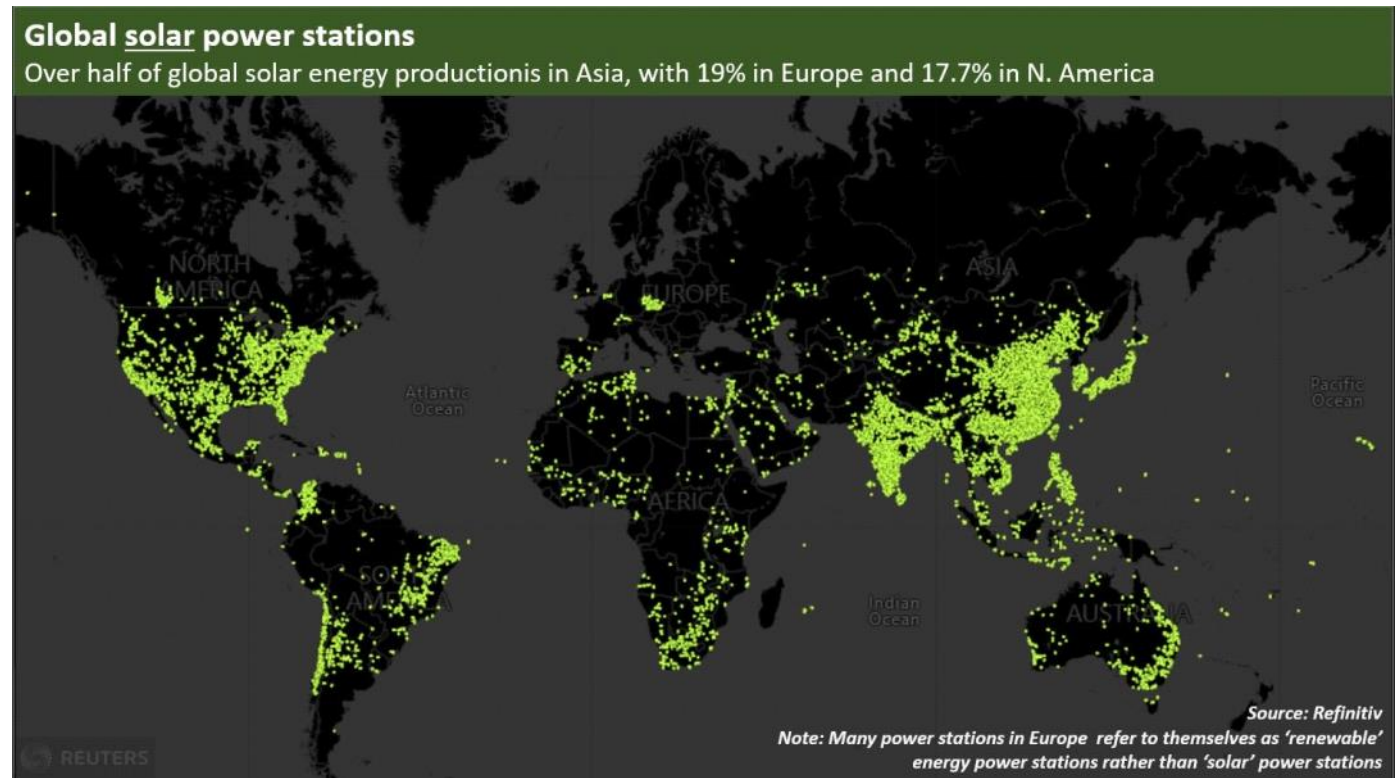- Expensive to research

BEST USED FOR:
- Geothermal Energy
- Lithium extraction
- Modular nuclear reactors (raf thinks they'll never work)

General Game Mechanics

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The main screen is a picture of the globe. Ideally it is constantly moving and changing with different forms of energy production/manufacturing plants depending on the state of the game. At the start of the game, the map should be Smokey and have things that indicate pollution.

Throughout the game, small green, yellow, blue, and red bubbles pop up throughout the map indicating a variety of events across the map.

Global solar power stations
Over half of global solar energy productionis in Asia, with 19% in Europe and 17.7% in N. America

Source: Refinitiv
Note: Many power stations in Europe refer to themselves as 'renewable' energy power stations rather than 'solar' power stations

This might be an example of what the map could look like after several bubbles have been popped in a game. The green bubbles will leave a permanent dot on the map indicating that the region is using renewable energy. The red bubbles will temporarily leave a red dot until it is replaced by a green bubble. Blue bubbles will create dotted lines connecting the regions that are sharing energy exports. Finally, the Yellow bubbles do not leave any permanent or temporary markers.

As the game progresses ideally the map starts going from smokey to having green streaks of wind and rays on sunshine representing a greener planet. We could also have masses of ice begin to flow in regular patterns as a way of showing that global warming has stopped or slowed.

The game ends when a certain percent of the planet has become 'green' or when a certain amount of red bubbles have popped.

A possible future update may include difficulty levels where you start in different states of history like the Industrial Revolution. Furthermore, the higher difficulties could have events that endorse non-renewable energies like war or foreign policy making management yellow and red bubbles far more important.

Bubbles

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Green Bubble:
- Each green bubble indicates the implementation of 'X' amount of renewable energy plants in the area.
- These include:
    - Solar
    - Wind
    - Hydro
    - Thermal
    - Nuclear
- Each technology excels and spreads faster in different parts of the world depending on the situation. Thus, every technology is needed to beat the game.
- Each bubble popped will give a certain amount of "Green Points" that will help upgrade your technology and make it more efficient.

Yellow Bubble:
- Each yellow bubble will indicate a part of the world that has undergone some sort of green advocation. These can take the form of:
    - Treaties signed by countries
    - Social advocacy groups
    - Protests
- This mechanic will be an indicator that the society in a specific region has become more "green forward" or "green minded".
- It will also have some sort of random component to it but the likelihood that it occurs will be affected by a couple of factors.
    - In a region that has not had a green bubble in a long time or has had red bubbles the chances of a reform will increase.
    - In a region that has reached a very high level of green bubbles the chances of surrounding areas will increase.
- When a yellow bubble is popped that means that the rate at which green energy is adopted in that region will increase by a set amount.
- Popping a yellow bubble also has the chance of randomly developing a technology for you for free.

Red Bubble:
- These bubbles are indicators of negative growth. This can occur due to neglect of a specific area. For example, if no thermal energy is developed for an extended period, countries like Iceland will begin investing in non-renewable energy sources instead of green sources.
- A red bubble being popped will decrease the rate at which green energy sources are adopted in an area. This will make the player think about how to better affect that region with different technology and upgrades.

Blue Bubble:
- The blue bubble won't be unlocked until later in the game after you unlock hydrogen fueling.
- Unlocking hydrogen fuel will allow for green transportation and the export of energy. This means that regions that need specific technology to produce energy can import it instead.
- Depending on the tier of the hydrogen fueling tree, exports of energy will be possible only

between neighboring regions, regions in the same continent, and worldwide.
- Energy will only be available for export if a region has excess green energy (when a region is covered in green dots).
- These bubbles will also have a random component to them as well but only after the technology has been upgraded. The more green dots a region has, the more likely they are to export energy.

Skill Tree

Hydrogen Fueling Branch
1. Hydrogen Transport I: Allows the export of energy between neighboring regions.
2. Open Trading I: Increases the likelihood of new trade route establishment.
3. Hydrogen Transport II: Allows the export of energy between regions in the same continent.
4. Open Trading II: Increases the likelihood of new trade route establishment.
5. Hydrogen Transport III: Allows the export of energy between any two regions.

Carbon Capture
1. Carbon Capture I: Increase the chances that a green dot replaces a red dot.
2. Carbon Capture II: Increase the chances that a green dot replaces a red dot.
3. Carbon Capture III: Increase the chances that a green dot replaces a red dot.
4. New Age Carbon Capture: Replace all red dots with green dots. (Cannot upgrade until High Tech Trait is active)

Renewable Fuels
1. Wind Power: Regions can generate energy via wind power
2. Solar Power: Regions can generate energy via solar power
3. Hydro Power: Regions can generate energy via hydropower
4. Thermal Power: Regions can generate energy via thermal power
5. Nuclear Power: Regions can generate energy via nuclear power. Increases the rate of energy generation but decreases the rate of adaptation (green bubbles).
6. Nuclear Fusion: Increases the rate of energy production with no downsides. (Cannot upgrade until High Tech Trait is active)

Carbon Offsets
1. Carbon Offset Awareness: Increase the chances of a yellow bubble appearing by generating awareness about carbon offsets.
2. Social Advocacy: Increase the chances of yellow bubbles appearing by applying social pressure to large corporations
3. Political Advocacy: Increase the chances of yellow bubbles appearing by increasing the amount of 'green' policy passed by regional governments.
4. Carbon Neutral: Increase the rate at which yellow bubbles appear in areas neighboring highly green areas by going completely carbon neutral using carbon offsets and encouraging similar policies in surrounding regions.

Batteries
1. Better Batteries I: Increase energy efficiency in an area allowing for more energy to be exported from a region.
2. Better Batteries II: Increase energy efficiency in an area allowing for more energy to be exported from a region.
3. Better Batteries III: Increase energy efficiency in an area allowing for more energy to be exported from a region.

Quality of Life Tech
1. Green Planet: Pops new green bubbles automatically.
2. Higher Education: Increased higher education leads to increased research in emerging technologies, decreasing the cost of renewable technologies.

3. High Tech: Allows for the development of technologies that do not yet exist.
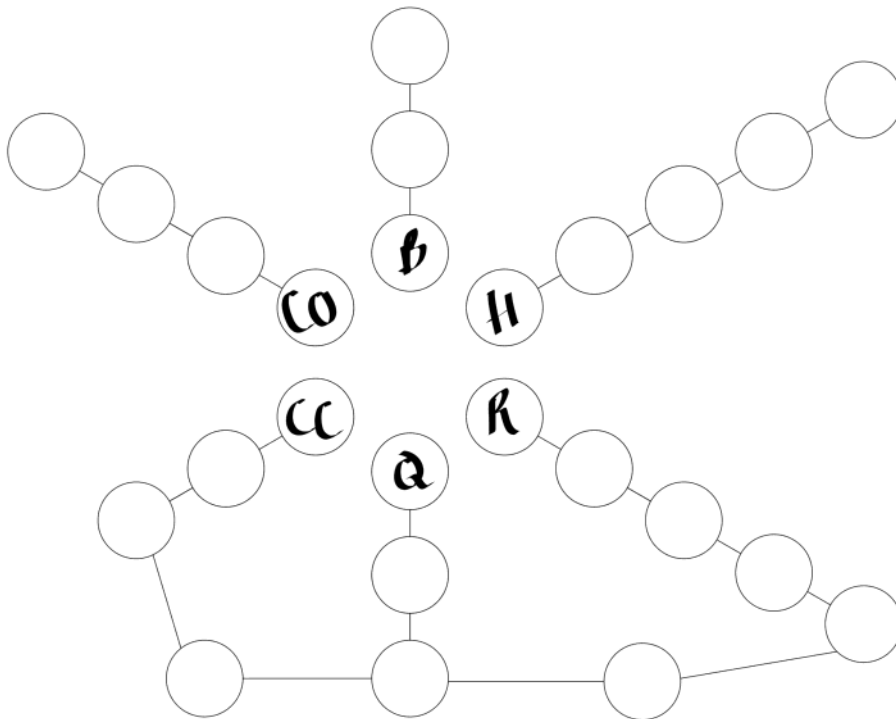
In this skill tree, we can make small designs to represent each technology. After you click one of the technologies on the tree, it will give a brief description and the amount of green points required to acquire.

These are some examples of possible symbols:

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Challenges

1. Generating points over time and making them make sense. Overhead for generation and simulating all of the events at the right time. Attaching events to time is hard.
   a. Ex. When a yellow bubble pops should time stop while you read or should it keep going?
2. Defining regions and their preferred energies.
3. Are we making a big enough impact? How do we increase our impact? News prompts?

TODO List

Overview:
1. ~~Translate from lat/long coords to a place on our map~~
2. Load in the events to Unity
    a. Need date, country, latitude/longitude, energy type
    b. Sorted by date
3. Generate bubbles for each event and have them show up in the game
4. Make the bubbles clickable, and have this trigger an action (?)
    a. Once bubble is clicked, it goes away and is replaced by a dot of the corresponding color
    b. Make Red dots replaceable by green dots when conditions are met
5. Create a GUI element (popup?) that can show information
6. Figure out how to load in data
    a. Preprocessing step (manipulate data in Python, only grab what we need)
    b. Data frame equivalent for C#?
7. Create user data for what energies are unlocked
    a. Enum?
8. Add time component
    a. Time.deltaTime

Stretch:
1. Create dotted line component connecting a pre-existing green dot and an importing country/region
2. Give player ability to zoom in/out
    a. Bubbles/dots should scale appropriately
3. Increase dot sizes with corresponding capacity of the plant
4. Make look pretty

Devin:
1. ~~Figure out platform/tools to make this thing happen~~
2. ~~Get a basic map on the screen to start with~~

1. Display the map and get points to be able to pop up
2. Split into different regions and make decisions based on that
3. Time system (days? Weeks?)

Raf:
1. Design tech tree
    a. Background pic
    b. Info conveyed when clicked
2. Help adding events after first few are done

Assets

World Map image: File:Mercator-projection.jpg - Wikipedia
Bubble Sprites: Glossy Bubbles | 2D Icons | Unity Asset Store

Date 26/02/2024:
EMPTY

Date 30/02/2024:
Three red dots pop up
  - Bad Energies:
    ○ China
    ○ Europe
    ○ Middle East
Wind Power is purchased
  - Display pop-up about 'wind power'

Date 10/03/2024:
green dot pops up in the at mines
  - Display pop-up 'Green Bubbles'

Date 20/03/2024:
5 green bubbles pop up across the US
Solar-power is purchased
  - Display pop-up 'solar power'

Date 30/03/2024:
2 green bubbles pop up:
  - Check countries chosen in DF
China red dot turns into green bubble
  - Display Pop-up 'Red to Green'
Auto-popping green bubbles is purchased.

Date 10/04/2024:
3-5 more green bubble pop up in each place with existing green point
Hydro power is purchased
  - Display pop-up 'hydro power'
Hydrogen Fueling is purchased
  - Display pop-up 'hydrogen fueling'

Date 30/04/2024:
10 more green bubbles show up in the US
blue bubble appears in the US and Canada
        -Display Pop-up 'blue bubbles'
Switzerland and China get a green bubble.

Date 12/05/2024:
Display pop-up 'Hint'
Geothermal Power is purchased
  - Display pop-up 'Geothermal power'
Green bubble pops up in Iceland

Date 25/05/2024:
Yellow bubble shows up on Middle East red dot
  - Display pop-up 'Yellow Bubbles'
Carbon Offsets is purchased
  - Display pop-up 'Carbon Offsets'

Date 02/06/2024:
Yellow bubble appears near last red point
  - Display pop-up 'Red to Yellow'
Display pop-up 'New Technology'
Carbon Capture is given
  - Display pop-up 'Carbon Capture'
25 new green bubbles appear in new places and already green countries
  - 10 in US
  - 1 in UK, Germany, Norway, France, Spain (Due to yellow bubble in Europe)
  - 5 in Iceland
  - 5 in another preexisting country

Date 30/06/2024:
  - Display pop-up 'Green World'

 Dots Needed:

Red:
  - China
  - France
  - Saudi Arabia

Green:
  - 1 US at Mines
  - 30 US Wind
  - 5 UK Solar
  - 5 IND Solar
  - 1 SWI Hydro
  - 1 CHN Hydro
  - 1 ISL Geoth
  - 1 DEU
  - 1 ESP
  - 1 ITA

Date 26/02/2024:
Empty map

Date 30/02/2024:
Three red dots pop up
  - Since Chevron is based in US choose points in China, Europe, and Middle East
First upgrade is made for green energy
  - Wind power
  - Get pop-up about the benefits and drawbacks of wind power

Date 10/03/2024:
First green dot pops up in the US
  - Check data for where but most likely west coast (maybe on top of mines for Easter egg)
Show pop-up that explains that popping green bubbles give green points to upgrade skill tree

Date 20/03/2024:
5 more green bubbles pop up across the US
Second and Third upgrade is made
  - Solar-power
  - Get pop-up about the benefits and drawbacks of solar power

Date 30/03/2024:
2 green bubbles pop up in 2 new countries
China red dot turns into green bubble
  - Pop-up shows up and explains that green dots can replace red dots.
Fourth upgrade is made
  - Auto-popping green bubbles.

Date 10/04/2024:
3-5 more green bubble pop up in each place with existing green points
  - They pop automatically
Fifth upgrade is made
  - Hydro power
  - Get pop-up about the benefits and drawbacks of hydro power

Date 30/04/2024:
Over this time, 10 more green bubbles show up in the US
After these 10 points show up, a blue bubble appears in the US
  - A blue dotted line appears between US and Canada
  - Pop-up explains how blue bubbles work
  - Get pop-up about the benefits and drawbacks of Hydrogen fueling
Switzerland and China get a green bubble.

Date 12/05/2024:
Pop-up hint
  - "Did you know that 66% of energy produced in Iceland is geothermal"
Sixth Upgrade is made
  - Geothermal Power
  - Get pop-up about the benefits and drawbacks of geothermal power
Green bubble pops up in Iceland right after you exits skill tree

Date 25/05/2024:
Yellow bubble shows up near Middle East red dot
  - Pop-up explains yellow bubbles
Seventh upgrade is made
  - Carbon Offsets
  - Get pop-up about the benefits and drawbacks of carbon offsets

Date 02/06/2024:
Yellow bubble appears near last red point
  - Pop-up about a treaty being signed by the EU to go carbon neutral by 2050 appears.
  - Immediately after pop-up, there is another pop-up explaining that you were given a new technology.
  - Carbon Capture technology is given
  - Get pop-up about the benefits and drawbacks of carbon capture
25 new green bubbles appear in new places and already green countries
  - 10 in US
  - 1 in UK, Germany, Norway, France, Spain (Due to yellow bubble in Europe)
  - 5 in Iceland
  - 5 in another preexisting country

Date 30/06/2024:
Green bubbles keep spreading
World starts getting a few more aesthetically 'green' features
Demo stop

1. Bubble pop up in specific locations.
2. Skill tree and unlocking tech
   a. Upgrading a tech leading to new green points
3. Hints feature
4. Auto-popping tech?
5. Replacing red/yellow dots with green

  - Wind
  - Solar
  - Hydro
  - Thermal

  - Auto-pop
  - Hydrogen fueling
  - Carbon offsets
  - Carbon Capture

Pop-Up messages

Yellow Events:

- "As China becomes the number 1 producer of carbon emissions, Chinese citizens become weary of grey skies and shift to a more ecofriendly mindset."
- "New study shows that exposure to high concentrations of green-house gasses in pregnant women lead to birth defects. Politicians are pressured to pass legislature to combat greenhouse emissions."
- The United Nations reaches an agreement

Timeline Events:

- Red dots:
  - "Red bubbles are indicators that a non-renewable energy plant has been created. Too many red bubbles will lose you the game! Red bubbles can be a result of neglecting a country's energy needs, economic struggles, or political power moves."
- Wind Power:
  - "Wind power is the cheapest renewable energy per kWh. China is the world leader in wind power generating 655,600 GWh. Did you know that offshore wind power has the potential of generating 18 time the current global energy demand!"
- Green dots:
  - "Green bubbles are indicators that a renewable energy plant has been created. Pop-each green bubble to earn 'Green Points' that can be used in the technology tree."
- After 5+ Green dots:
  - "It looks like renewable energy is spreading! Each region has different energy needs that utilize some technologies better than others. Keep upgrading the 'Renewable Fuels' branch in the technology tree to find out what technologies are used in each region and why."
- Solar Power:
  - "Solar power is the most abundant and popular renewable energy source globally, accounting for 3.6% of the global energy needs today. Solar power is best used in sunny climates in tandem with horticulture and agriculture."
- Red to Green:
  - "Looks like one of the red bubbles turned green! This can happen by targeting red dots in specific regions with technologies that are more efficient in those regions."
- Auto-popping bubbles:
  - "The world is going green! This technology will help you keep up with the demand by popping green bubbles for you."
- Hydro Power:
  - "Hydro Power is the cheapest amongst all renewable energy sources, at only 2 to 4 cents (USD). Hydro power is often heavily reliant on existing natural features like rivers, high tides, and springs."
- Hydrogen Fueling:
  - "Hydrogen fueling provides a clean energy source for long distance travel. While it still requires much research, hydrogen fueling shows promise in heavy and long distance travel like public transport and shipments.
- Blue bubble:
  - "Blue bubbles are indicators that a clean energy trade route has been established. Countries that do not have access to renewable energies may instead import clean energy from countries with a surplus. Keep upgrading the 'Hydrogen Fueling' branch to increase the

range of exports."
- Hints:
  - "Did you know that 66% of Icelands energy comes from geothermal energy plants?"
- Geothermal Power:
  - "While geothermal power does not have the energy capacity to compete with wind and solar, it is the most constant renewable energy source. It is especially useful in areas with lower energy demands that struggle to implement other renewable energies"
- Yellow Bubbles:
  - "Yellow bubbles are indicators that a social, economic, or political event has turned the tide of renewable energy in a specific region. These events can be positive and influence renewable growth in a region or lead to implementation of non-renewable energy plants. These events also have the chance of developing new technologies for you."
- Carbon Offsets:
  - "Carbon offsets are a medium for individuals and corporations to be held accountable for their greenhouse emissions. Entities can trade emissions by investing in renewable projects simultaneously. By applying social and political pressure to large entities, we can help reduce the impact of their carbon emissions via carbon offsets."
- Red to Yellow:
  - "With increasing awareness of ecocide in European states, the EU is pushed to sign a treaty to go carbon neutral by 2050."
- New Technology:
  - "You have developed a new technology— Carbon Capture!
- Carbon Capture:
  - "Carbon Capture helps reduce emissions in areas with high concentrations of greenhouse gasses by physically removing carbon from the atmosphere. Upgrading this branch increases the chances of a red bubble turning green."
- Green World:
  - "The world is going green! Keep upgrading your technologies and combating climate change one day at a time!

Final Video Sketch

Sunday, February 25, 2024   9:39 AM

Queues for Upgrading:

1. | 3 Red bubbles and pop-up | | 2024-05-05 |

   a. HYDRO POWER UPGRADE

2. | 5 green bubbles in US and pop-up | | 2024-10-10 |

   a. SOLAR POWER UPGRADE

3. | Ton of greens across US, UK, and India | | 2025-05-01
2025-05-15 |

   a. HYDRO POWER PURCHASED
   b. HYDROGEN FUELING PURCHASED

4. Iceland Hint

   a. | GEOTHERMAL POWER PURCHASED | | 2026-02-10 |

5. | 1 green bubble pops in Iceland | | 2026-04-10 |

   a. CARBON OFFSET PURCHASED

Points to touch on for Raf:

A. Idea Stuff
   a. Problem Statement
      i. Youth does not know where and when renewable technologies should be utilized to maximize efficiency.
   b. Challenge
      i. Cannot explain all best-use scenarios due to the high volume and density of information.
      ii. Kids don't like to read or feel like they are reading
   c. Solution
      i. Gamified learning
      ii. kids are incentivized to learn about renewable energies through a competitive and interactive simulation

      d. Enacting Solution
           i. Small optional excerpts that will help you beat the game but are also real-life facts about renewable technology.
           ii. Replay-ability encourages and rewards deeper learning of the topic
B. Game Mechanics
    a. Overview
           i. Simulation of the Earth adopting renewable energy.
           ii. As you research new technologies you expand your reach to different parts of the world
    b. Bubbles
           i. The main mechanic of the game is the bubbles. Each bubble represents a different event. Each bubble pop also gives 'Green Points' which allow you to upgrade technology.
           ii. Each bubble has a randomization component to it that increases the replayability of the game. A new experience every time.
           iii. Green Bubbles
               1) Represent the building of a new renewable energy plant.
               2) Leave a marker to represent the standing energy plant
           iv. Red Bubbles
               1) Represent the building of a non-renewable energy plant.
               2) Leave a marker representing the standing energy plant.
               3) These can be converted to green markers through some other game mechanics.
               4) Too many red markers will end the game as a loss.
           v. Yellow Bubbles.
               1) Yellow bubbles represent social, economic, or political events that have a positive or negative impact on renewable energy development.
               2) A yellow bubble also has the chance to develop a new technology for the player for free.
               3) The effects and frequency of these will change with varying difficulty modes and will be the primary mode of keeping the game fresh and increasing replay-ability
           vi. Blue Lines
               1) These are indicators of energy exports occurring between two different regions.
               2) Blue lines allow for more strategic playthroughs of the game and become more important as the difficulty increases.
    c. Skill Tree
           i. The skill tree is where you explore and research new technology.
           ii. Each branch within the tech tree has a series of nodes that impact a different aspect of the game.
           iii. The tree has 6 branches that impact:
               1) Types of renewable energies available
               2) The rate at which yellow bubbles spawn
               3) The rate at which red bubbles turn green
               4) Allowing for exports of energy
               5) Increasing efficiency of energy plants leading to more exports
               6) Ease of life upgrades like auto-popping bubbles
           iv. To upgrade each of these nodes, you require 'Green Points' earned by popping bubbles.
           v. The order and time at which you make each upgrade increases versatility and encourages discovering new playstyles.
    d. Hints
           i. Throughout the game the player receives hints about how to target specific regions of the map.
           ii. These hints are always real-life facts about renewable energy that inform the player

about the best-case uses for each energy type.

       iii. The player is never forced to read these and can dismiss them but the game heavily rewards the use of the hints. This makes the user feel like they are playing a game rather than being forced to learn.

       iv. One of the ways we reward learning is by having such high versatility and replayability in the game. The more you play, the more hints you learn and the more knowledge you have about targeting different parts of the world, therefore making you better at adapting to unforeseen scenarios.

C. Data and Research
  a. Nodes
     i. To make this game come to life we needed real data points about energy plants.
     ii. We used a data bank with nearly 35,000 data points.
       1) Each of these points contains information on:
         a) The country
         b) The company name
         c) The energy capacity in MW
         d) Latitude and Longitude location
         e) The primary fuel type
         f) 3 other fuel types used
       2) In the future we hope to incorporate more of this information, especially the capacity, into the game as well. This would increase the complexity of the game further increasing replayability.
         a) We hope that you can zoom in on the map and press specific energy plants to learn more about the fuel source being used, its capacity, and the company/organization supporting it.
     iii. By manipulating this data using the pandas library we were able to quickly sort points into respective energy types, countries, etc. Using the newly sorted data frames we were able to make every bubble in the game correspond to a real energy plant of that same type.
       1) This makes it so that the player is learning about where renewable energy efforts are strongest by simply looking at the map and playing.

  b. Research
     i. The main need for research came from generating hints.
     ii. We want each hint and breaking news event to be real events that we have seen in recent history.
       1) For this reason, the game would require updates on the hints it gives.
       2) For example, if the EU reaches a green deal after COP29, we would like to incorporate it into the game so that players have the treaty in the back of their minds and know about major green events around the world like COP29.
         a) This way, if the player wishes to do further research or hears about it on the news, the can be more receptive to the information.

D. The Game
  a. Unity Engine
     i. The entirety of the game was made in Unity using C# scripts.
     ii. This made it easy to develop a friendly interface to demonstrate the feel of the product.
     iii. However, we are by no means game designers and this was both of our first go's at Unity and game design as a whole.
     iv. There was a steep learning curve but I think that we made great progress in the short amount of time we were allotted and with the consideration that this was a 2 person team.
     v. For our MVP we made a short tutorial of the game that a new player might see as their first playthrough.