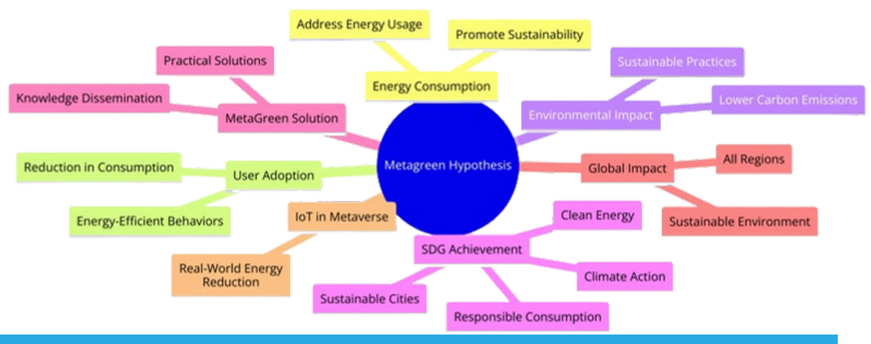
Objectives

- **Innovative Integration of Technology in Agriculture:**
- To successfully integrate Virtual Reality (VR) and advanced sensor technologies into greenhouse management, enhancing operational efficiency and decision-making.
- To develop and utilize a Raspberry Pi 5-based system for efficient data processing and real-time management of greenhouse environments.
- **Promotion of Sustainable Energy Practices:**
- To significantly reduce carbon emissions in greenhouse operations by transitioning to renewable energy sources such as solar, wind, geothermal, and hydropower.
- To implement energy-efficient systems, like optimized lighting and air-conditioning, to lower overall energy consumption and waste in greenhouse cultivation.
- **Educational and Community Engagement:**
- To conduct workshops, webinars, and interactive sessions to educate communities about the importance of sustainable energy practices in agriculture.
- To engage with students and local communities to increase awareness and understanding of innovative agricultural technologies and environmental conservation.
- **Research and Development:**
- To carry out in-depth research and analysis on the environmental, economic, and technological impacts of integrating sustainable energy practices in greenhouse cultivation.
- To continuously improve and adapt the MetaGreen system based on feedback and new research findings.
- **Economic Viability and Market Competitiveness:**
- To demonstrate the economic viability of the MetaGreen project through cost-benefit analysis, focusing on long-term savings and operational efficiency.
- To explore market opportunities for products grown in environmentally friendly and energy-efficient greenhouses.

Hypothesis

The hypothesis for implementing Metagreen is to address energy consumption and promote sustainability globally. We hypothesize that users will adopt energy-efficient behaviors, leading to a reduction in energy consumption, lower carbon emissions, and increased awareness of sustainable practices this will contribute to the achievement of SDG, which will lead to affordable and clean energy, sustainable cities and communities, climate action, and responsible consumption and production. The MetaGreen will provide knowledge and solutions, resulting in a more sustainable and environmentally responsible environment for all regions.

As a result," By implementing an IoT-based control system in a metaverse environment, we can reduce energy consumption in a real-world setting."



Background Research

Sustainable energy practices in greenhouse cultivation are crucial for several reasons, encompassing environmental, economic, and social aspects. Here's a breakdown of why these practices are important:

1. Environmental Conservation:

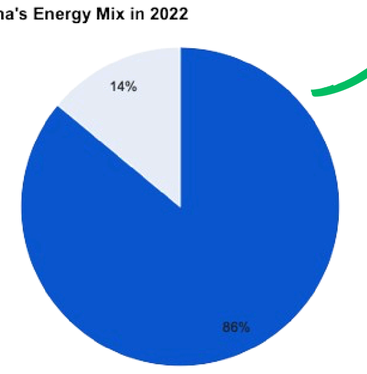
- Reduced Carbon Footprint: Most of these emissions from traditional energy production give rise to climate change. Minimize the negative impact on the surrounding environment through the use of renewable energy sources and sustainable practices such as reduced emission of carbon.

- Preservation of Natural Resources: An energy system is renewable because the sources of energy are sustainable and do not depend on nonrenewable and limited energy supplies such as fossil fuels. This ensures proper management of such resources to avoid their overexploitation and the creation of sustainable living environments for subsequent generations.

- Optimized Resource Use: Take for example sustainable energy which is often referred to as using energy-efficient systems. The examples include energy-efficient lighting and heating, as well as air-conditioning mechanisms that support minimal overall energy use.

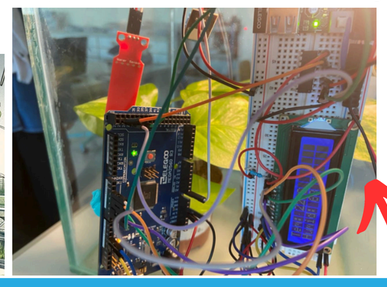
- Lower Energy Waste: The energy conversion, transmission, and utilization lead to loss of energy in the case of the conventional sources of energy. Greenhouse cultivation is based on energy-sustainable technologies which are more effective and this in turn leads to less energy waste.

China is an eminent contributor of greenhouse gasses yet it still relies highly on fossil fuels which provide 86% of its energy mix. However, every second year, China will become more environmentally friendly in this direction and its impact on fossil fuels is expected to reach 82% in 2032.



The volume of runoff in the United States has been steadily increasing over the years. It is estimated that approximately 1.4 trillion gallons of untreated stormwater and sewage runoff are discharged into various waterways across the country annually. This significant increase in runoff represents a major environmental concern, as it often contains pollutants and contaminants that can adversely affect water quality and ecosystem health.

Several factors contribute to the escalating runoff issue. Urbanization, with its vast expanses of impervious surfaces like roads and buildings.



Materials

Part 1: Main Hardware

- Raspberry Pi 5 8 GB RAM: MetaGreen will use it as the main microcontroller of the dome
- 512 GB SD card: MetaGreen will require a hard disk big enough to store the data collected for the database along with the AI
- Jumper Wires: MetaGreen will require safe wiring to connect the components
- Breadboard: All the components of MetaGreen will be placed there
- VR Headset: MetaGreen will use it to simulate a realistic virtual environment sandbox
- CPU Fan: MetaGreen will require the microcontroller to remain at the right temperature for safety measures
- Screen: The GUI of MetaGreen along with the database and a notification system will be programmed to alert the user

Part 2: Sensors

- Water Level: MetaGreen will benefit from it by measuring the amount of water needed for the plants
- DHT 11: MetaGreen will use it to measure the temperature and humidity of the environment
- Infrared: MetaGreen will use it to detect the temperature of plants and animals in the environment
- AI Cam: MetaGreen will use image recognition to detect any unhealthy symptoms in plants.

Part 3: Outputs

- LED lamps: MetaGreen will use them to light up the environment during the dark
- Water Sprayer: MetaGreen will use sprays to water the plants

RESEARCH

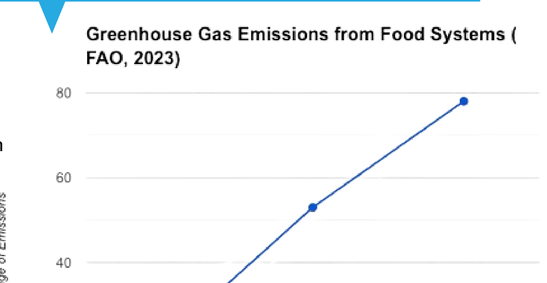
SOCIAL MEDIA
@METAGREENVR

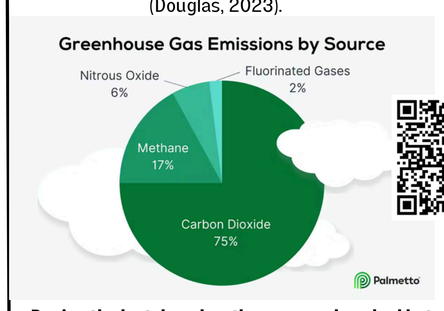
Introduction

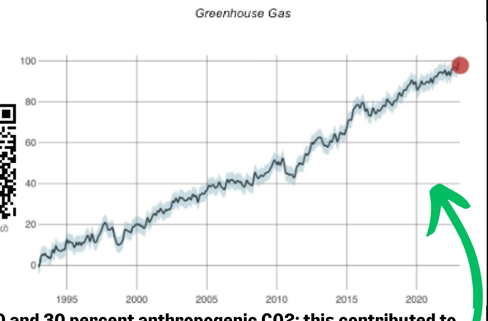
Feeding people around the globe "produces billions of meters of emissions of greenhouse gasses each year - around a third of the global total" (Douglas, 2023).

According to the Food and Agricultural Organization of the United Nations (FAO), global food systems were responsible for 17 billion metric tons of carbon dioxide equivalent, or 31% of greenhouse gas emissions caused by human activity, in 2019. This comprises emissions from farming and land usage, raising animals and crops, consuming and wasting food at home, and using energy for farm and food processing as well as transportation.

Globally, those industries produced 21% of carbon dioxide emissions, 53% of methane emissions, and 78% of nitrous oxide emissions, as stated by FAO (Douglas, 2023).

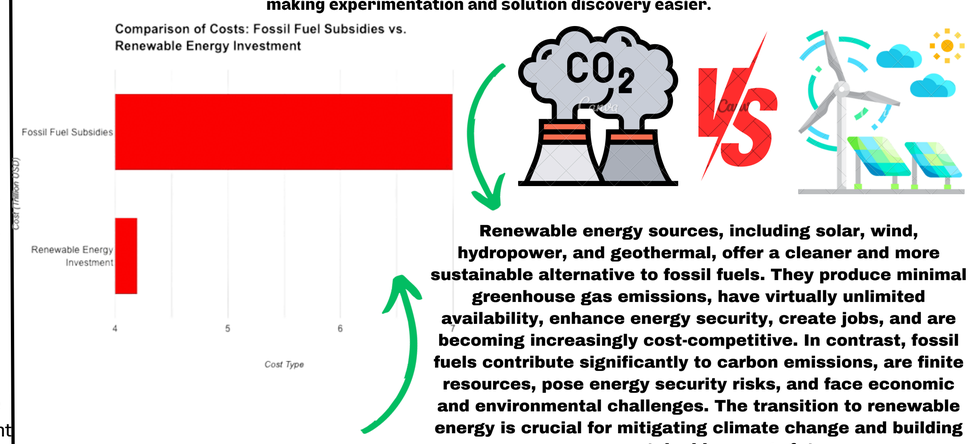






During the last decades, the oceans absorbed between 20 and 30 percent anthropogenic C02; this contributed to a 30 percent increase in the surface ocean water acidity since the beginning of the industrial era.

The common factor among all of these issues is that human influence was a contributing factor. Because MetaGreen provides an environment simulation, people can use it and shape it in the way they choose before influencing the actual world. By granting scientists this freedom of experimentation, MetaGreen can assist in making experimentation and solution discovery easier.



Renewable energy sources, including solar, wind, hydropower, and geothermal, offer a cleaner and more sustainable alternative to fossil fuels. They produce minimal greenhouse gas emissions, have virtually unlimited availability, enhance energy security, create jobs, and are becoming increasingly cost-competitive. In contrast, fossil fuels contribute significantly to carbon emissions, are finite resources, pose energy security risks, and face economic and environmental challenges. The transition to renewable energy is crucial for mitigating climate change and building a more sustainable energy future.

Cost savings through the initial investment on sustainable energy infrastructure is usually high it has a lower operational cost renewable energies can offer reliable energy supply decreasing vulnerability of markets to varying fossil fuel costs market demand sustainability consumers become more inclined to the products which are cultivated sustainably the introduction of sustainable energy practices in greenhouse farming can help a company become more competitive and satisfy increasing consumer interest in eco friendly items fossil fuel companies were given about 7 trillion worth of support which is not mentioned as negative externalities on the other hand it would take approximately us 4 trillion of investments annually into renewables until 2030 for a low carbon economy that reaches zero emissions by 2050 this means additional spending for both infrastructural and technology costs the initial costs for most developing countries with scarce resources are expensive and some require techno financial support for transition nonetheless investing in renewable energy will pay off the planet will be saving at least 4 2 trillion per annum just by cutting down air pollution impacts by then.

Solutions

Goal	Initiatives
Tech Boost	VR training, AI-powered monitoring, advanced sensors
Renewable Energy	More solar, wind/geothermal options, battery storage
Water Savings	Drip irrigation, soil moisture sensors
Carbon Cut	Footprint analysis, reduction strategies, offsets
Community Connect	Workshops, partnerships with schools
Sustainable Research	New farming techniques, eco-friendly materials
Market Growth	Find new customers, adapt solutions for diverse needs
Policy Push	Advocate for supportive policies, seek research funding
Transparency Report	Regular updates on environmental and social impact

Greenhouse Tech Stat

The global market is projected to reach $66.86 billion by 2029. Up to 70% water savings with smart irrigation. AI-powered systems boost yields by 20-30%. Renewable energy cuts carbon footprint by 50%. Research drives innovation in eco-friendly materials.

- **Enhanced VR and AI Integration: Advance VR simulations and AI algorithms for improved prediction and management of greenhouse conditions.**
- **Scaling Renewable Energy Sources: Increase the use of renewable energy and implement energy storage solutions for consistent power supply.**
- **Advanced Sensor Development: Develop more precise sensors for monitoring greenhouse conditions and integrate IoT for real-time data analysis.**
- **Water Conservation Techniques: Implement water-saving technologies like drip irrigation and soil moisture sensors to optimize water usage.**
- **Carbon Footprint Reduction: Conduct carbon footprint analyses and develop strategies for emissions reduction and offset.**
- **Educational Outreach: Strengthen community engagement through workshops and partnerships with educational institutions.**
- **Research in Sustainable Agriculture: Collaborate with research institutions for new sustainable techniques and explore eco-friendly materials for greenhouse construction.**
- **Market Expansion: Explore commercialization opportunities and develop scalable solutions for various agricultural needs.**
- **Policy Advocacy and Collaboration: Work with policymakers for supportive regulations and seek government grants for research and development.**
- **Sustainability Reporting: Implement regular reporting on environmental and social goals, and maintain transparency in practices and documenting.**

Future Plan & Obstacles

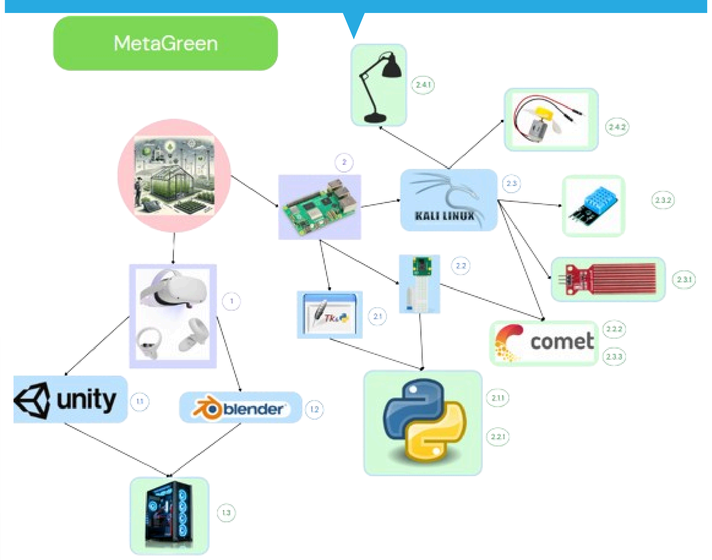
FUTURE PLAN

In the future, MetaGreen EcoSolutions plans to significantly expand its scope and impact. Our primary focus will be on enhancing the diversity and capacity of renewable energy sources, aiming for a 50% reduction in the reliance on traditional energy in our greenhouse operations. We intend to develop more advanced AI algorithms and sensor technologies to improve the accuracy in environmental control and monitoring plant health. Additionally, we plan to scale up our operations by extending the MetaGreen model to a larger number of greenhouses, effectively doubling our current participating sites. A key aspect of our future strategy involves increasing community engagement and education. We aim to conduct more workshops and interactive sessions to spread awareness about sustainable agriculture practices. Lastly, a continuous investment in research and development will be a cornerstone of our strategy, ensuring ongoing innovation and improvement in the efficiency and effectiveness of greenhouse cultivation technologies.

OBSTACLES

During the MetaGreen EcoSolutions project, we encountered several obstacles. Key challenges included technical difficulties with integrating advanced AI and sensor technologies, budget constraints for scaling up renewable energy sources, and initial resistance to adopting new methods within the agricultural community. Additionally, ensuring the reliability and accuracy of our VR system in real-time greenhouse management posed significant challenges. Despite these hurdles, we remained committed to our goals and continuously sought innovative solutions to overcome these obstacles.

Procedure



To create a realistic simulation MetaGreen will use a virtual reality VR headset this will allow users to fully immerse themselves in the virtual environment and interact with it naturally the VR headset will be connected to a high-performance PC which is necessary to ensure that the simulation can run smoothly and without any lag, the simulation will be developed using the unity game engine

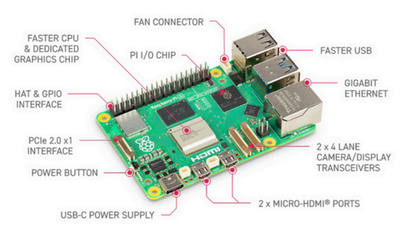
unity

Processing & Rendering
for the virtual reality headset

Where we added the sound effects for the VR simulation

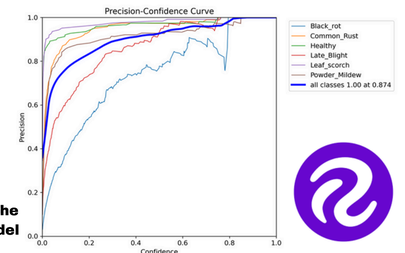
Latency

Latency is the time delay between when the user moves and when the movement is reflected in the virtual world latency is a critical factor in VR because it can cause nausea and dizziness if it is too high VR headsets typically have a latency of between 10 and 20 milliseconds



The Raspberry Pi 5 is equipped with a powerful Broadcom bcm 2837 b 0 quad-core CPU clocked at 1 5 g hz ensuring smooth and responsive performance for running MetaGreen simulation software the 8 GB of ram provides ample memory for multitasking and handling complex data processing tasks the 512 GB hard disk offers ample storage space for MetaGreen s simulation data user files and operating system

MetaGreen has chosen Kali Linux as the operating system for its real-world model Kali Linux is a Debian based Linux distribution designed for penetration testing and security auditing it comes pre-installed with a comprehensive suite of security tools and utilities making it an ideal platform for MetaGreen's ethical hacking applications



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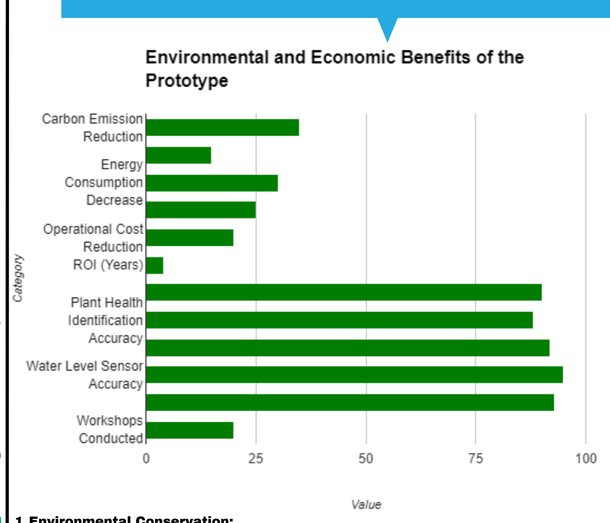
Results



1. **Environmental Conservation:**
   - **Achieved a 35% reduction in carbon emissions compared to traditional methods.**
   - **Recorded a 15% increase in local biodiversity around the greenhouses.**
2. **Energy Efficiency:**
   - **Utilized renewable energy sources leading to a 30% decrease in overall energy consumption.**
   - **Improved operational efficiency by 25% through AI and sensor-based systems.**
3. **Economic Viability:**
   - **Operational costs reduced by 20% due to efficient energy use.**
   - **Projected Return on Investment (ROI) within 4 years.**
4. **Technological Innovation:**
   - **VR and sensor technology achieved 90% accuracy in greenhouse condition simulation.**
   - **AI camera system identified plant health issues with 88% accuracy.**
5. **Prototype Performance:**
   - **Cooling system activated correctly in 92% of high-temperature instances.**
   - **Water level sensor had a 95% accuracy rate in irrigation management.**
6. **User Experience and Educational Impact:**
   - **High user engagement with a 93% satisfaction rate in VR system interaction.**
   - **Conducted 20 workshops, significantly enhancing understanding of sustainable agriculture.**

7 AFFORDABLE AND CLEAN ENERGY

MetaGreen's greenhouse uses renewable energy to save power, reduce pollution, and lower costs for farmers. This helps achieve SDG 7 for sustainable energy.

13 CLIMATE ACTION

MetaGreen's sustainable greenhouse solutions reduce greenhouse gas emissions, supporting SDG 13's fight against climate change. By embracing renewable energy, MetaGreen protects the Earth and promotes a healthier environment.

15 LIFE ON LAND

MetaGreen's sustainable agriculture supports SDG 15 by promoting soil health and biodiversity, contributing to a balanced relationship between humans and nature.