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SUSTAINABILITY ANALYSIS ON SMART GRID MODEL WITH UNMANNED AERIAL VEHICLES

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Abstract - *The World has reached a tipping point in recent years due to the adverse effects of technological advancements. In tandem with the escalating use of technology, global temperatures continue to rise, with grave ramifications for the viability of many things that are regarded as natural. This paper examines the benefits of unmanned aerial vehicles (UAVs) in terms of sustainability and renewability, which are crucial to technological advancements. Due to their position at the vanguard of the technological change, unmanned aerial vehicles (UAVs) can evolve to collect data for environmental protection projects. UAVs, which contain technology that can support the work of climate change and environmental researchers, play a crucial role in the implementation of sustainable solutions, and serve the renewable energy infrastructure, can do all of these things better, easier, faster, less expensively, and more safely. UAVs can be used in the sky for a variety of purposes, including increasing the efficiency of solar power plants or photovoltaics (PVs) and wind power plants (WPPs), supporting the use of clean energy, increasing the efficiency of agriculture, remotely monitoring endangered animal species, and assisting scientists around the world in their research. It is crucial to build and implement UAVs in order to give renewable energy companies with a potent productivity tool and to assist scientists in preparing for the complicated effects of climate change and environmental degradation.*

Key Words: Renewable Energy, Sustainability, Smart Grid, Unmanned Aerial Vehicles.

1. INTRODUCTION

Our planet is continually subjected to global climate change. The use of fossil fuels (coal, oil, and natural gas) as a source of energy for electricity generation, transportation, industry, and residential use increases the emission of greenhouse gases caused by humans. In addition, it adds to the alteration of land use and the enhancement of waste's greenhouse effect. Consequently, the world faces a worldwide threat. Each year, the repercussions of global climate change intensify. In order to develop solutions to the challenges that may emerge in the coming years, it must utilize modern technology. Thanks to technology, humanity is always evolving and becoming more aware. Innovative applications are developed to leave future generations with a better world. Unmanned aircraft systems are examples of these inventive applications. Unmanned aerial vehicle (UAV) is the abbreviation for a type of aircraft that does not contain humans [1].

Fig -1: Flighting Uav or drone.

The UAV is a robot-like device that is operated remotely or flies autonomously utilizing software-controlled flight plans. Unmanned aircraft is sometimes known as a drone. Unmanned aerial vehicles have risen from the realm of science fiction and become a reality over the past decade. Initially, it was intended for military purposes, but as its development progressed, UAVs began to be utilized as espionage and surveillance vehicles in everyday life. UAVs may also monitor and optimize power usage. These sensors consist of orientation and stability, chemical, laser or LiDAR, time of flight, and distance sensors. Using b-sensors, UAVs efficiently monitor and map broad regions, conduct environmental studies, fly to hazardous and inaccessible locations, and prevent wildlife from entering restricted areas. These instruments monitor the weather, soil humidity, and conduct scientific study. It flies to hazardous and inaccessible sites and inhibits wildlife from entering restricted zones. Figure 1 depicts an example of an unmanned aerial vehicle.

UAVs benefit the environment in a number of ways. As this technology progresses, its effect on the environment becomes increasingly tangible. These are the different ways in which drones benefit the environment.

- Transportation and shipping,
- Monitoring and protection of wildlife,
- Monitoring of renewable energy;
- Creating intelligent applications for the agriculture sector;
- Rehabilitation of forests;
- Mapping and environmental monitoring;
- Monitoring of ocean health;
- Land Management.

Transportation and logistics are the primary beneficiaries of UAV technology. This is due to the fact that UAVs can access inaccessible regions, such as warehouses, terminals, and shipping container ports.

Unmanned aerial vehicles are beginning to emerge as a sector that has drastically altered the delivery of commercial items. Unmanned aircraft use less energy per package-kilometer than delivery trucks. It is anticipated that this function will cut greenhouse gas emissions and energy consumption.

For example, product generators; Amazon tested its drone delivery services for the first time with success in December 2016 and has announced that it would continue to investigate this technology.

Amazon [2], Google [3], UPS [4], and Deutsche Post DHL [5] are among the organizations implementing programs for package delivery with drones. The trucking business accounts for 24% of transportation-related greenhouse gas emissions and 23% of transportation energy consumption in the United States [6], therefore improvements in the industry are crucial for the environment and energy system [7].

As power systems grow, the environmental benefits of charging drones with electricity will rely on the environmental aspects of electricity's life-cycle, vehicle use, and battery materials.

Previous research has demonstrated that delivering commodities per ton-kilometer by conventional airplane is approximately four times more carbon-intensive than by truck, which is around ten times more carbon-intensive than by rail [8]. Using drones to transport packages instead of trucks can cut emissions connected with package delivery. Drone delivery makes it possible to make deliveries fast and efficiently.

Figure 2 depicts delivery UAVs. However, their carrying capacity is limited. Despite this, this means of transportation is environmentally friendly.

Unlike air, rail, road, and sea transport vehicles, drones are powered by batteries and emit no hazardous gases into the atmosphere. Additionally, drone transport and delivery reduces traffic congestion on our roadways.

Fig -2: UAV usage for deliver [2].

When evaluated within these scopes, unmanned aerial vehicles can be used in university campuses for environmental protection also helping for university students living in the campus are in the smart society class in terms of their ability to both use IoT technology and adapt to innovations. This concept was implemented to adapt the smart grid model for smart campuses. When designing the smart campus for this study, a Matlab campus model was constructed, and the needs of the smart grid concept CO_2 level, as illustrated in Figure 3 and calculated on this model, were reviewed [9].

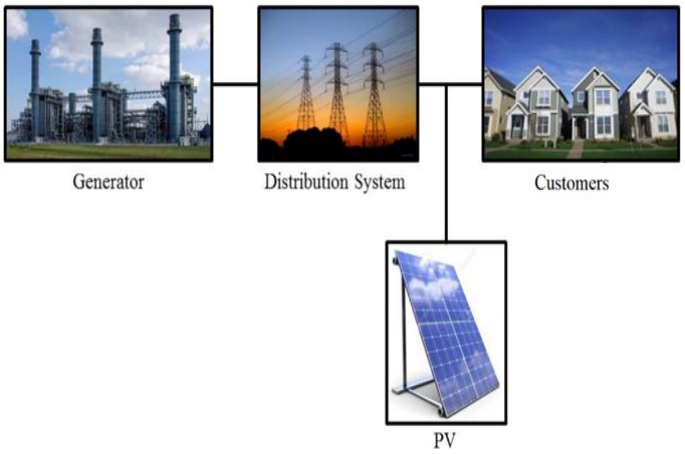

Fig -3: Basic Infrastructure Design of Smart Grid.

There will be fewer trucks carrying solely heavy cargo on the road. The greatest drawback of this mode of transportation is that it can only convey less large objects. As the technology advances, it is anticipated that both the device's carrying capacity and its range will rise. Consequently, there will be a huge decrease in atmospheric carbon, especially if the drone's batteries are charged with renewable energy. However, the rate of climate change will moderate, and the quality of life on Earth will improve.

2. APPLICATIONS ON SMART GRID WITH UNMANNED AERIAL VEHICLES

2.1. Natural life monitoring and preservation

Drones are utilized for emergency environmental missions in addition as supplying researchers with data to boost conservation initiatives. In wildlife management, drones assist with animal counting, research, and protection. Sometimes, wildlife and weather conditions can be hazardous and demanding. Drones can prevent human life from being endangered. Due to the drones' overhead perspective, objects that cannot be seen properly from the ground can be seen clearly.

Figure 4 depicts the group application for Sea Shepherd's ocean conservation campaign across the Indian Ocean and South China Sea, which employs drones to monitor illegal fishing. Poachers kill between 20,000 and 40,000 elephants annually, or one elephant every 15 minutes. In the past decade, poaching-related elephant fatalities have outpaced their reproduction rate. The illegal trade in ivory has reduced the African elephant population from 1.3 million in 1970 to only 400,000 today [2-8].

In recent years, anti-poaching drones have made a significant and novel addition to numerous anti-poaching strategies. The Mara Elephant Project focuses on elephant conservation in the Masai Mara, Kenya, and deploys conservation drones to prevent poaching. Drones equipped with specialized thermal cameras send live video to teams, often miles away, and record photos for subsequent analysis. Organization, It has apprehended hundreds of poachers and seized over one thousand kilograms of ivory since its beginning. The percentage of illegally murdered elephants has fallen from 83% to 44% due to the Mara Elephant Project [9].

Fig -4: Sea Shepherd's Ocean conservation group [8].

It can be seen with the Mara Elephant Project and Sea Shepherd's Group, unmanned aerial vehicle technology is used to monitor animal species in danger of extinction.

2.2. Renewable energy usage monitoring

The capacity of a drone to span vast areas and offer high-resolution overhead photos has enabled numerous businesses to increase their efficiency when undertaking hazardous or time-consuming activities. By giving correct data to solar farm management via new technology innovations such as drones and thermal sensors, everyday activities can be conducted more efficiently. The Energy Industry combines cutting-edge technology with drones to increase the efficiency of power plant operations, and drones play a crucial role in their efforts to offer customers with dependable and economical energy. Many countries throughout the world are boosting their investments in renewable energy projects in response to growing worries about climate change and carbon emissions. Among numerous renewable energy sources, solar energy has been deemed the best option. During the recent decade (2009-2019), global investments in solar energy surpassed US$1.3 trillion, representing half of all assets contributing to the expansion of renewable energy [10].

Installation costs have decreased significantly, which has contributed to the widespread adoption of solar solutions (Photovoltaics). For instance, solar installation costs decrease by roughly 73% between 2010 and 2019, from $4,622 to $1,210 [11]. The current objective is to continue making solar energy globally cheap. To accomplish this, solar managers must optimize operations and create value throughout the entire process of power generation. Solar enterprises must install thousands of solar panels across expansive, generally heavily irradiated areas in order to meet their electricity needs. A solar farm would need roughly 2,500 acres to power 100,000 homes [12].

Traditional solar field assessments, It involves inspecting each panel with handheld thermal cameras to check for faulty cells or cables. During this process, the worker must manually monitor the positions of the defective panels and perform maintenance later. Given the size of most solar power plants, this method of inspection is inefficient and results in a heavier and sometimes dangerous workload for maintenance and operations teams. Drones are constantly being used in solar farms to improve inspection operations, particularly in areas with high radiation exposure and creating a host of problems for field crews. The use of drones shortens the inspection time of solar farm crews by 70%, providing a significant reduction compared to traditional methods. Figure 5 shows Solar UAV monitoring applications.

UAVs can be used to collect data or transmit it in real time to teams on the ground. Detailed reports detect turbine blade corrosion and malfunctions, enabling wind farm managers to reduce both efficiency losses and maintenance costs. To overcome key challenges such as low efficiency, high costs and poor inspection data quality, many wind farm operators around the world have started using drones for wind turbine inspections. Tripoli, Greece, a drone services provider founded in Athens, Greece in 2017 "IDS - Industrial Drone Services" Company, together with its customers Eunice Energy Group (EEG), one of the pioneers in the field of renewable energy in Greece, has a total capacity of 34. They used DJI drones from their drone platform to inspect a 5 MW wind farm. With winters providing less than 10 hours of daylight on average, using traditional inspection methods would have been extremely time consuming and therefore expensive.

Normally, a full inspection of a single wind turbine with inspectors working at height can take between 3 and 6 hours. This does not include lengthy security procedures and preparation time. On the other hand, with DJI being windproof, it only takes 45 minutes for RTK drones to fully examine a turbine. This allows the entire 15 turbine farm to be inspected within three days [13].

Fig -5: Solar UAV Monitoring [10].

2.3 Development of Smart Agriculture in the Agricultural Sector

Agricultural drones are unmanned aerial vehicles used to assist conventional agricultural labour and optimize the agricultural process, thanks to their sensor and image tracking capabilities. They have integrated GPS systems, tracking mechanisms, and more suitable for farming. These systems will take weeks for a farmer to assess conclusively. It provides a complete view of fields and crops. This not only increases productivity, but also increases crop yields and overall production. Agricultural drones in smart agriculture obtain a 3D map thanks to ground mapping, can plant crops, are used for spraying crops, obtain result data by monitoring the field, and provide a healthy evaluation of crops by tracking irrigation and fertilizer. Drone technology has recently been used in almost every field of agriculture. There are specially programmed drones used in soil analysis, planting, pesticide spraying, monitoring and many other parts of agriculture and farming. In Turkey, the first AUAV (agricultural unmanned aerial vehicle) sold in the region was delivered by Silivri Agricultural Credit Cooperative affiliated to Tekirdağ Regional Union of Agricultural Credit Cooperatives. While the use of agricultural unmanned aerial vehicles in agriculture makes agricultural life easier, drones that can take up to 30 liters of pesticides are preferred by farmers who want to save time, water and pesticides. With the increase in the use of drones in agriculture, both the country and the farmers are making serious gains in terms of productivity. UAUVs, which spray in a short time without damaging the plants, can spray 30 decares of land by staying in the air for an average of 12 minutes. With pesticides made from the air, pesticides are applied quickly and efficiently in the detected diseased areas [14]. Overall productivity is increasing thanks to agricultural drones. The human workforce is declining. It results in better crop production and higher yields in the long run.

2.4 Improving green areas

Also in the UAE, oil distribution group CAFU has used drones at every stage of an ambitious tree planting project. In March 2021, 10,000 Ghaf trees were successfully planted by drone in the Dubai desert. The process started with drones used to scan potential planting sites and measure the suitability of soil, wind and moisture. Drone was used to determine the best spots for seeds to plant and a map was created with GPS markers for drone-enabled seed drops. Monthly drone inspections are conducted to monitor the progress of each tree [15].

Fig -6: Solar UAV Monitoring [10].

Reforestation is time consuming, costly and labor intensive when relying on human labor. Unmanned aerial vehicles for reforestation, it can map and identify areas where trees need to be planted and make planting faster and more efficient. First, the drones map the space to give a layout for planning and implementation to begin. Second, drones monitor the growth of new trees. Third, they map and drop seeds where they don't germinate. Unlike the natural afforestation method, where animals leave seeds through feces, drone afforestation technology is more advanced.

2.5 Developing with mapping

Drones are also incredibly good at mapping and tracking. They can gather information from large coastal areas, allowing specialists to use photogrammetric image processing tools to create detailed maps. Poaching and unlawful activity monitoring; change tracking over time; and other types of mapping and monitoring, Protection of plants and riverbanks; monitoring of coastal management; evaluation of rivers and floods; management of animals and their habitats; modelling of land and hydrology; and management and monitoring of forests. Drones are equipped with cameras, pressure and humidity sensors, thermometers, wind gauges, and other equipment to effectively gather important environmental data. The good news is that they can enter even dangerous environments.

3. DISCUSSION AND CONCLUSIONS

UAVs are developing rapidly in parallel with the advances in electronics and software technologies. Although UAVs were developed only for military missions in the early days, their use for civil and commercial purposes has also increased to a great extent.

UAV systems have become very useful thanks to their ability to stay on. It can carry a large payload. Thanks to this logistics feature, it has become the choice of many cargo and delivery companies. In recent years, we have come across UAVs in many fields apart from the military field. Scientific research, delivery, and UAVs are used in places where manpower is limited and there is a safety hazard, such as mapping and smart agriculture. Climate change is now becoming a global problem all over the world. This global problem has led technology companies to change their vision and mission. It aims to support technology with green energy resources by making use of sustainable and renewable resources.

If the battery and load-carrying capacity of unmanned aerial vehicles are increased, it may be possible to encounter more UAVs in the sky in the coming years. In the coming years, land vehicle use will decrease, and unmanned aerial vehicles with renewable battery capacity will take their place. UAVs will support sustainable agriculture with the help of special sensors, irrigation, spraying, and visual tracking and increase efficiency. Agriculture will develop; animal species in danger of extinction will be protected; the challenging conditions of scientific research will be overcome; the maintenance of renewable resources such as solar and wind power plants will be done by saving time and cost without endangering human life. Many countries, including Turkey, are working on this issue. and leading technology companies also support countries.

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