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Studying the Possibility of Smart Farms based on solar System Using (IoT) Technology in Libya

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Electricity in Libya
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Internet of things
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ABSTRACT

Study the possibility of using a smart farm based on solar system as the first source of electricity in Libya, as an economical solution, and we will study the monthly climate in Libya for the average temperature. And the amount of electrical power required and the efficiency of use; to design a solar system with an appropriate capacity to cover all the needs of the farm. And we will rely on (Internet of Things) technology in this farm to control it remotely. A soil moisture sensor will be used to monitor the moisture content of the soil; a float water level sensor will be used to monitor the water level in the tank; and a 16 x 12 LCD will be used to display the soil and tank status and turn on the water pump when the moisture content of the soil falls below a predetermined level, provided there is enough water in the tank.

دراسة إمكانية المزارع الذكية القائمة على أنظمة الطاقة الشمسية باستخدام تقنية (إنترنت الأشياء) في ليبيا

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الكلمات المفتاحية:
الطاقة الشمسية
الكهرباء في ليبيا
المزرعة الذكية
إنترنت الأشياء
لوحة الأردوينو

الملخص

دراسة إمكانية استخدام مزرعة ذكية التي تعتمد على الطاقة الشمسية كمصدر أول للكهرباء في ليبيا، كحل اقتصادي، سنقوم بدراسة المناخ الشهري في ليبيا لمتوسط درجة الحرارة وكمية الطاقة الكهربائية المطلوبة وكفاءة الاستخدام؛ لتصميم نظام شمسي بقدرة مناسبة لتغطية كافة احتياجات المزرعة. وسنعتمد على تقنية (إنترنت الأشياء) في هذه المزرعة حتى نتمكن من التحكم فيها عن بُعد . وسنقوم بمراقبة رطوبة التربة باستخدام مستشعر رطوبة التربة، ومراقبة مستوى المياه في الخزان باستخدام مستشعر مستوى المياه (مفتاح تعويم) وتشغيل مضخة المياه عندما تنخفض رطوبة التربة عن مستوى محدد إذا كان الخزان يحتوي على كمية كافية من المياه وعرض حالة التربة والخزان باستخدام شاشة LCD مقاس 16 × 12.

1. Introduction

Libya is the 17th largest oil producer in the world, hence the country's energy industry is mostly dependent on oil. Libya's economy heavily depends on oil exports, which provide the lion's share of government and foreign exchange revenues. But there are also serious drawbacks

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to this reliance on oil, such as environmental issues including water and air pollution from oil spills and refining operations. Furthermore, Libya's oil reserves are predicted to decrease over the next several decades, making the country's energy industry less viable. This has raised questions about the industry's long-term sustainability and the necessity of diversifying into other energy sources like solar and wind power. A sizeable amount of Libya's total energy consumption is accounted for by the country's agriculture sector, which uses a lot of electricity. The primary reasons for the industry's dependence on electricity are the usage of pumps for irrigation and the requirement for electricity to run agricultural machinery and storage facilities. Nonetheless, there are several ways Libya's agriculture industry may cut back on its use of electricity, helping to create a more sustainable and energy-efficient future.

A smart farm uses IoT systems to remotely control devices, allowing soil sensors to measure moisture and signal with red or green lights if crops need water [1].

We can point out that using this smart farm saves us effort, time, and comfort for the owner, as he does not need to go to it every time, but he can see what is happening only by using the Internet on his phone. Using sustainable energy, such as solar power, instead of depending on the public grid ensures a reliable source of electricity. This energy is secure from theft or failures due to long transmission distances. It is particularly useful for water pumps, crop irrigation, lighting, and other devices that the owner may need [2].

The movement toward smart agriculture is shown in Fig. 1 IoT Devices and Sensors: These comprise a range of sensors, including pH, light intensity, temperature, and humidity sensors, as well as soil moisture sensors. These gadgets gather data from the agricultural environment in real time. A data transmission network ensures that information from the Internet of Things sensors reaches a central system smoothly. Wi-Fi, LoRaWAN, or cellular connections may be used for this network, depending on the infrastructure and location of the farm. Central Control System: A platform that uses cloud computing resources to compile data from several sensors.

This technology can automate agricultural activities, analyze data, and offer insights that can be put to use. Which plays a role in increasing productivity and protecting the environment, is making an appearance in the food service sector as an indoor smart agriculture restaurant. The study set out to look into how customers make decisions when dining at indoor smart farming establishments. As the first empirical investigation of consumer behavior in the context of indoor smart farming, this study contributes theoretically and provides useful recommendations from the standpoint of green marketing [3].

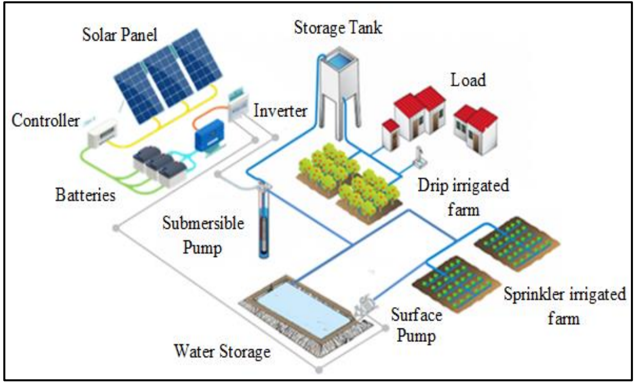

Fig 1. The movement toward smart agriculture

In Libya, solar energy is one of the most promising forms of renewable energy. Libya has a good solar resource, with high levels of sun irradiation over much of the nation. Libya is thought to be capable of producing up to 3 million gigawatt-hours (GWh) of solar power annually. As of 2022, Libya's installed solar capacity is anticipated to be very small, at about 10 megawatts (MW). Nonetheless, the government has set lofty goals for renewable energy, with a major emphasis on solar energy, to have 22% of power come from renewable sources by 2030. Libya has several benefits from solar energy, including plenty of sunshine, a huge amount of land accessible for solar projects, and declining costs for solar technology. Because of this, solar energy is a desirable alternative to help meet the nation's expanding energy needs [4].

Libya is a country in North Africa that has the Mediterranean Sea to its north. Libyan agriculture relies mostly on irrigation, although productivity is severely constrained by the country's low renewable water supply, harsh weather, and poor soils. Approximately 75% of the food needed to meet domestic needs is imported by the state due to low agricultural yields. Libya consists mainly of flat to undulating plains and 95% desert. This makes many areas of the country susceptible to sandstorms, dust storms, flooding, desertification as well as the country's Mediterranean climate.

Climate variability is expected to exacerbate the effects of natural hazards on agricultural productivity, and climate change poses a serious risk to Libya's economic development and sustainability.

Climate variability is expected to exacerbate the effects of natural hazards on agricultural productivity, and climate change poses a serious risk to Libya's economic development and sustainability.

Libya has extremely high solar radiation levels; typical daily values vary from 5.5 to 8 kWh/m2 depending on the area of the nation. Libya experiences an average of 2,000–3,000 kWh/m2 of solar radiation annually, with certain regions experiencing more than 3,500 kWh/m2. Libya boasts one of the greatest annual sunlight hours per year figures in the world, averaging between 3,000 and 3,600 hours every year. Summertime is the best time to receive solar radiation; in certain areas, daily levels can reach 8 kWh/m2 in July and August. Wintertime sun radiation is reduced but still very intense.

Global horizontal solar irradiation (GHI) is a measurement of the total solar energy received at a certain spot, both direct and diffuse, on a horizontal surface. It is a crucial metric for assessing a region's potential for solar energy, in Table 1. The global horizontal solar irradiation (GHI) data for Libya:

Table 1. Libyan Monthly Average GHI (kWh/m²/day)

Months	GHI (kWh/m²/day)
January	4.35
February	4.65
March	5.15
April	5.65
May	6.15
June	6.65
July	7.15
August	7.35
September	6.85
October	6.15
November	5.45
December	4.75

Due to its year-round, highly steady, and bright sunlight, Libya's southern and central areas have the largest solar resources. Fig 2 shows Monthly climate precipitation, average surface air temperature, average maximum surface air temperature, and average minimum surface air temperature per month. Libya 1991-2022. Where the green color shows the average minimum air temperature, the yellow color shows the average air temperature, the red color shows the average maximum air temperature and the color shows the precipitation.

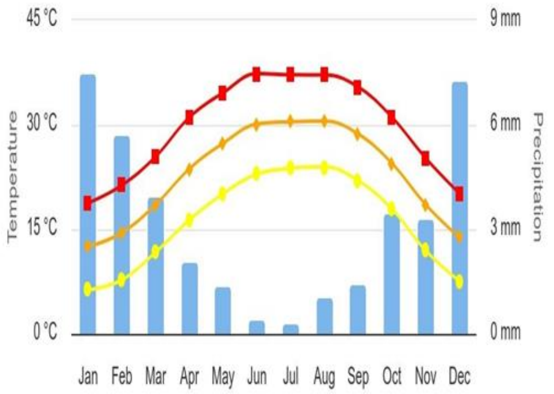

Fig 2. Monthly climate in Libya for the average temperature.

Libya's monthly climate from 1991 to 2022 shows valuable insights into the country's climate patterns and changes over the years. Analyzing this data can help in understanding seasonal trends and long-term changes in temperature and precipitation, which are critical for various sectors such as agriculture, water resource management, and infrastructure planning [5].

Building a solar power plant, whether for investment or to serve agricultural projects or homes, can save a lot of money in the long run. The importance of establishing solar power plants is increasing due to the need for safe energy, especially in the remote, mountainous, and desert areas of Libyan cities, as well as the fact that solar energy is a clean source that does not pollute the desert environment, which is known for its clean air.

In addition to being a clean source that does not pollute the desert environment, it is known for its clean air. Considering the high prices of oil and gas, solar energy is cheaper than other energy sources such as oil compared to solar cells, which are known to last for 30 years [6]. The use of solar energy in farms is easy, especially in countries where the sun is abundant and the cost of using ordinary fuels such as diesel or gas is scarce or high, as there are solar panel water pumps in these areas, allowing better production and lower cost. In addition to its important role in generating electricity for millions of deprived people around the world, the use of solar energy in agriculture contributes to increasing the efficiency of crops, in addition to achieving financial returns for farmers, especially as the cost of solar panels continues to decrease, and many countries are moving to increase their manufacturing capacities [7].

Libya has the potential to become a global leader in the field of renewable energy. It has a very high daily solar radiation rate, which is about 7.1 kilowatt hours per square meter per day (kWh/square meter/day) in the flat coastal plain and about 8.1 kWh/square meter/day in the southern region. According to research published in the Journal of Renewable Energy, the figure shows that Libya could create more than five times the amount of PV system if it used a photovoltaic system to harvest only 0.1% of land mass [8].

Libya could meet all of its electricity needs and export a significant portion of the needs of its neighbors in southern Europe. If there are supportive policies from the Libyan government to integrate photovoltaic energy, surplus electrical energy from solar panels will be integrated with Libya's electrical grid to cover part of the increase in electrical energy demand in the summer.

Libya's geographical location can help in generating solar energy to power administrative buildings, telecommunications, air conditioning, and lighting [9].

The Libyan General Electricity Company has signed an agreement with Total Energies in Libya to implement projects to generate electricity from photovoltaic systems with a capacity of up to 500 megawatts. The implementation of the first solar energy project in Libya is to solve the crises in the electricity sector. The country's electricity deficit has reached about 2,500 megawatts per day. This has led most Libyans to rely on private generators. The General Electricity Company seeks to increase its capacity to 14,834 MW by 2025 and 21,669 MW by 2030 [10].

Using photovoltaic cells, solar energy is directly converted into electrical energy in many countries. Many of them were also considering using the concentrated solar thermal method as a source of heat for power plants.

These are the two methods by which electricity is produced from solar energy. Here, the article will provide the answer while comparing the two technologies, giving a brief overview of how and where they work, their geographical scope, and cost considerations while utilizing the experiences of other countries and the possibility of their use in Libya [11].

A rise in surface temperature causes a fall in power output. To achieve this, so determine the regions in which PV systems can function as effectively as under typical test circumstances. In addition to assessing the electrical behavior of PV systems and estimating their functional failure, to ascertain the surface cell temperature of a functioning PV system under actual operational and environmental parameters (load, solar radiation, and environment) [12].

Rooftop solar systems' environmental friendliness and adaptability have drawn increased attention. A thorough examination is conducted of the proposed system's technical and economic viability, taking reliability and cost into account. System sizing is used as an example of a limited optimization problem [13].

To preserve our planet for future generations, intelligent modeling, analysis, and management of agricultural systems, soil use, and protection are crucial and will become increasingly critical. The whole value chain involved in agriculture and forestry must be covered by technological solutions. Cyber-physical systems that leverage big data, improved processing power, and agricultural advancements facilitate the digitalization process. Modern algorithms can perform better than humans in some jobs [14].

Farms in rural areas use a lot of energy and have comparatively low energy efficiency. The adoption of integrated resource management and renewable energy technologies has lagged behind that of the residential and industrial domains. Although the development of renewable energy sources was a significant stride in the past, it is insufficient now because it does not permit effective energy management [15], [16].

The controller's job is to choose irrigation technology that maximizes crop productivity while ensuring sufficient soil moisture levels for crops and minimizing water and energy use. To achieve this, the created predictive controller creates a limited optimization using soil moisture data at various depths [17].

The experimental results are used to evaluate an integrated system that includes renewable energy consumption and smart farm production. The suggested approach improves renewable energy consumption, accuracy (96.7%), and efficiency (95.6%) for smart farming, according to experimental findings and debate [18].

2. Implementing a Smart Farm in a Lab

The smart Farm in a Lab was implemented in the energy laboratory of the College of Renewable Energy Tajoura. Relies on solar energy as a source of electricity to operate the required loads in smart Farms. Such as operating the water pump and the programmed systems in the smart farm, such as the irrigation system that depends on the soil sensor, and also operating the lighting in it completely.

Where it was used a soil moisture sensor to monitor the moisture content of the soil, a water level sensor (float switch) to monitor the water level in the tank, and a 16x12 LCD screen to display the soil and tank conditions and turn on the water pump when the soil moisture content falls below a predetermined level if the tank is sufficiently filled. The smart farm's components as depicted in Figure 3. The elements of a smart farm are:

1. Greenhouse.
2. Solar panels.
3. Irrigation network.
4. Agricultural fields.
5. Warehouse.
6. Feeding station.
7. LDC monitor.

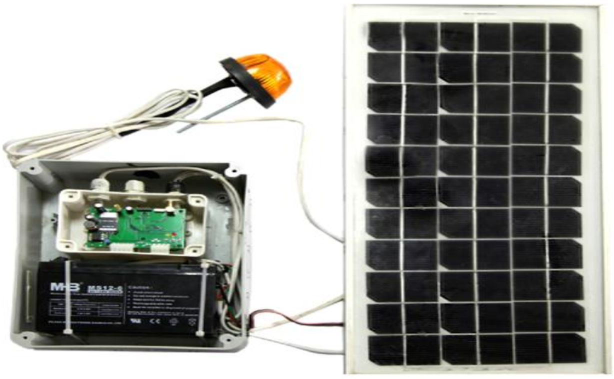

Fig 3. Components of the smart farm in the lab.

There are two output poles on the soil moisture sensor module that we will be using: an analog output and a digital output. The lm393 comparator is used to compare the moisture sensor output data to a reference value. The variable resistor in the sensor module is used to modify the reference value. When the soil is wet, the digital output electrode produces a digital output with a value of 0 low. Utilize the analog output of the sensor module by attaching it to one of the analog electrodes on the Arduino board.

The software will allow us to choose and modify the moisture detection value when we utilize the analog output. According to the circuit design, we feed the line with a 1kΩ resistor and link the liquid level sensor to one of the analog electrodes on the Arduino board. The Arduino board's analog electrodes can also be used as digital inputs. By examining the liquid level sensor's output, which the Arduino uses to detect the water level in the tank by measuring the voltage drop across the resistor, the condition of the tank is kept track of. The Arduino's second and third poles are connected to an LED to show the humidity and tank condition, respectively.

The Arduino's fourth pole is connected to the base of a transistor (BC547), which powers a 12V DC motor. 4-bit mode is used to connect the LCD to the Arduino. This sheet uses the JHD162A module, an LCD module built on the HD44780 drive circuit from Hitachi. With sixteen legs, this module can function in eight-bit mode by utilizing all eight data lines, or in four-bit mode by using only four data lines. Data pins D4 through D7 are connected to pins 11, 10, 9, and 8, respectively, on the Arduino board, while control pins Rs, RW, and En are directly connected to pins 13, GND, and 12, respectively.

Production of corn, sunflower, and rapeseed had shorter payback times (3 to 12 months). As a result, the intelligent irrigation system has benefits and is a reasonably priced option.

In Figure 4. The solar panel is used by the Arduino board's battery charging method. All of the data on the sprinklers' operation is shown via this system. The list of sprinklers in use is displayed. Machines in operation are denoted by green circles. Orange indicates that the machine has stopped. In addition, the Smart Farm contains information about turning off sprinklers.

Fig 4. A solar panel is used for battery charging

1) Smart Farm Programming Code

Programmers use the Arduino's built-in Liquid Crystal library, which is designed to work with LCD modules that employ Hitachi's HD44780 control chip or other similar chips, to make communication between the Arduino and the LCD module easier. Both the 4-bit and the 8-bit types of display transmission are supported by this library. Data is sent using four data poles and three control poles in 4-bit mode. Since the R/W pole is always connected to the ground, only six poles are required in 4-bit mode.

To select the poles during the binding process, turn on the library first. Then, use the command (Liquid Crystal LCD RS), E, D4, D5, D6, D7, where the poles are configured as follows, as shown in the figure (Liquid Crystal lcd 13, 12, 11, 10, 9, 8). These are the connections between the poles here: The sequence is as follows: RS electrode to 13, EN electrode to 12, D4 electrode to 11, D5 electrode to 10, D6 electrode to 9, and D7 electrode to 8. Using the read follower (analogRead), the Arduino reads the sensor output through the analog input electrodes. To ascertain the current soil condition, the voltage on A0 is compared with a specific number (avg_moisture).

For instance, the (analogReadmoisture_sensorPin) instruction translates the voltage within the range of 0 to 5V on A0 to a number (within the range of 0 to 1023). The current water level is ascertained by comparing the status of the liquid level sensor. The controller switches on and off the motor based on the conditions detected by both sensors. The circuit schematic for an Arduino-powered autonomous irrigation system is displayed in Figure 5.

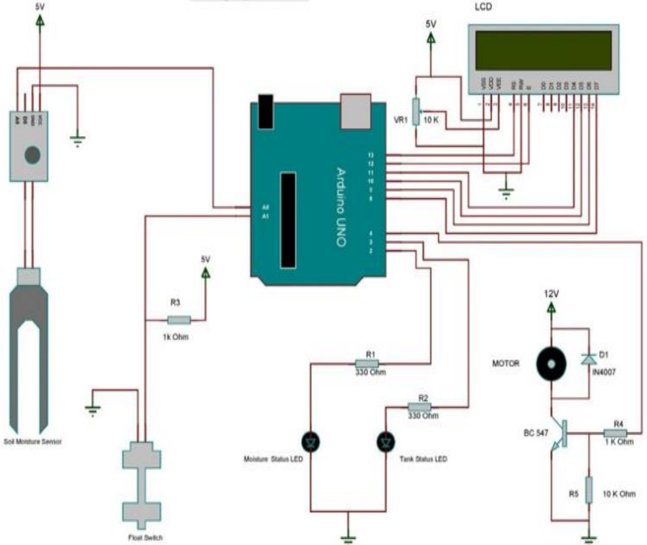

Fig 5. Circuit of an automated irrigation system using Arduino

2) Determined water requirements for Smart Farms

The drip system irrigates the trees by harnessing the energy of the earth's gravity through the placement of an upper tank around three meters above the surface [19]. The following formula can be used to determine the tank volume:

$$V_T=W_{tree}\cdot N_{(t/line)}\cdot N_{line} \tag{1}$$

So the **VT**: Voltage (V) represents the electrical potential difference between two points. **W**: Work (J) represents the energy transferred or converted. **tree**: Tree (unitless) represents the number of trees or plants being irrigated. **N**: Number (unitless) represents the number of units or quantities being measured. **t**: Time (s) Represents the duration of the irrigation cycle. **line**: Line (unitless) Represents the length or distance of the irrigation system

Determined the sprinkler irrigation system's water requirements the following formula can be used to determine the gross water application (depth of water used for a plant):

$$G_w = (M_w.\eta_{sys})/(D_f) \tag{2}$$

$$G_w/A = G\,(w_{inch}) \tag{3}$$

So **Mw**: Moisture content of the soil (%) Represents the percentage of water in the soil. **η sys**: System efficiency (%) Represents the efficiency of the irrigation system. **Df**: Field depth (m) Represents the depth of the soil or field being irrigated. **Gw**: Gross water application (m) Represents the total amount of water applied to the field. **A**: Area (m²) Represents the size of the field or area being irrigated. **G**: Gross water application rate (inch) Represents the rate at which water is applied to the field.

Determine the rate of volumetric flow the volumetric flow rate is determined by the following factors: the size of the field, the crop's maximum water consumption value, system efficiency, and irrigation cycle duration. The following equation [20–22] can be used to get the flow rate:

$$Q = (453.\,A.D)/(F.H) \tag{4}$$

So **Q:** Volumetric flow rate (L/s) Represents the rate at which water is flowing through the irrigation system. **F**: Field size (m²) Represents the size of the field or area being irrigated**. H:** Head loss (m) Represents the pressure drop or loss in the irrigation system.

Ascertain the sprinkler irrigation system's necessary storage capacity. Using the equation, the storage capacity was chosen to match the maximum daily water requirement of one cubic meter per day [23]:

$$V_{w,s} = A_{w,s}.\,D_{w,s} \tag{5}$$

So **Vw,s:** Storage capacity (m³) Represents the maximum amount of water that can be stored in the irrigation system. **Aw,s:** Water application rate (m) Represents the rate at which water is applied to the field. **Dw,s**: Duration of irrigation (s) Represents the duration of the irrigation cycle.

Determining the submersible pump's power capacity because it influences the number of solar panels and batteries needed, the pump's capacity (measured in kW) is a crucial component in the design of a solar system. It can use equation (6) to determine the pump's size:

$$P_{W,kW} = (TDH.SG.Q)/3960 \tag{6}$$

$$P_{act,\,kw} = P_{W,kW} / \zeta_{pmp} \qquad (7)$$

So **Pw,kW:** Pump power capacity (kW) represents the power required to pump water through the irrigation system. **TDH:** Total dynamic head (m) Represents the total pressure drop or loss in the irrigation system. **SG:** Specific gravity (unitless) Represents the ratio of the density of the fluid to the density of water. **Q:** Volumetric flow rate (L/s) Represents the rate at which water is flowing through the irrigation system. **Pact,kW:** Actual pump power (kW) Represents the actual power required to pump water through the irrigation system. **ζpmp:** Pump efficiency (%) Represents the efficiency of the pump.

3. Calculating the number of modules for the PV solar system

The solar system is dependent upon the local temperature, the number of peak sun hours each day, and the amount of radiation striking the modules. The following procedures are used to calculate the modules based on Smart Farms: Calculate the system's daily energy consumption (kWh/day). This ought to be included in the problem description. Find the location's average daily solar radiation (kWh/m2/day). This takes into consideration variables such as temperature and sun exposure hours. Find the module's peak power in kW (kWp). This represents each module's maximum power output under typical test circumstances. It will be included in the specifications for the module.

Find the module efficiency, which is typically expressed as a percentage, such as 20%. This converts the peak rating to real daily output while accounting for losses. Determine the required module area: (Average Daily Radiation x Module Efficiency) / Daily Energy Demand. Determine the number of modules required Module Area / Single Module Area In conclusion, the essential inputs are:

1. Daily need for energy
2. The location's average daily solar radiation
3. Peak power rating of the module
4- The effectiveness of the module.

The photovoltaic system's design data is displayed in Table 2. The design model of a smart farm is a medium-sized solar system made for comparable agricultural applications based on the information in the table. High-efficiency monocrystalline silicon is used in the PV modules, making them ideal for massive solar arrays. Each module has a rated output of 400 W, which is a typical size for industrial and commercial PV systems. The combined PV array capacity of 100 modules is 40 kW, which may supply a sizable amount of a smart farm's electrical requirements. With an excellent module efficiency of 20.4%, sophisticated photovoltaic technology is used.

Table 2. Data and information on solar photovoltaic systems [24-29].

Data	Value	Unit
Peak sun hours	5 to 7	hours
Efficiency collectors	90	%
Inverter efficiency	90	%
Efficiency PV System	80	%
Radiation density RETScreen®[21]	6.58	Kwh/m^2/day
Average solar radiation	0.8	kW/m^2
Type of cell	Mono-Crystalline	
Manufacturing	Grape Solar	
Model	Mono-Si-GS-S-385-TS	
System voltage	48	volte
Maximum Power P_{max}	385	Watt
Power for Module	364.8	watt
The voltage at Maximum V_{mpp}	48	Volt
Current at Maximum I_{mpp}	7.87	Amp
Open Circuit Voltage Voc 59.5		
Short Circuit Current Isc 8.36		Amp
Capacity of the inverters 10		Kw
Number of inverters 3		Inverters
Data	**Value**	**Unit**
Operation time	6	hours
Transformer efficiency	90	%
Temp effect at 40 °C	80	%
Efficiency battery	80	%
Depth Discharge	75	%
System voltage for batteries	48	vote
Battery Voltage	12	vote
Battery current	300	Ah
Anatomy day	3	days
Type of battery model	Exide 6E95-11	

4. Results and Discussion of Smart Farms

Using IoT technology in smart farms enables the mobilization of multiple devices to collect and analyze data and information so that better decisions can be made to collect and analyze data and information so that better decisions can be made. Some of the key outcomes of smart farms using IoT can be summarized as follows:

1. More accurate and efficient plant cultivation: Smart farm technology allows farmers to collect accurate data about temperature, humidity, soil, plant exposure, types of fertilizers, and the ideal time to harvest. This information can guide irrigation operations, improve resource utilization, and increase productivity.
2. Improved weather forecasting: By analyzing weather models and relying on information obtained from IoT devices, smart farms can accurately predict weather conditions and provide the right time for planting, irrigation, and harvesting. It can also help provide crop protection strategies against hurricanes, floods, and droughts.
3. Increase production efficiency: With smart farm devices that measure the soil, the amount of fertilizer used, and the serial movement of vehicles, this system allows farmers to make their operations more efficient and effective.
4. Save time and reduce costs: Smart farm technologies can analyze data logs and extract important information from them, which alleviates the need for farmers to constantly monitor plants or animals, so farmers can save time and costs in the process.
5. Reduce environmental risks: Smart farm technology allows farmers to accurately monitor their resources including water and land, enabling them to take the necessary actions to conserve resources, prevent land degradation, and significantly enhance the environment.

The smart farm based on solar energy can be used as the first source of electricity in Libya, as an economic solution that can calculate the amount of electrical power required and the efficiency of use; to design a solar system with a suitable capacity to cover all the needs of the farm. We must rely on the Internet of Things technology in this farm so that we can operate it from a distance. This gives us the ability to use sensors to track the water level in the tank and soil moisture, respectively, as well as to monitor soil moisture. If there is adequate water in the tank, activate the water pump and flip the float switch when the soil moisture falls below a predetermined threshold. A 16-by-12 LCD screen shows the soil and tank conditions.

Conclusions

Libya has suitable climate and soil conditions for implementing smart farming techniques. The warm climate allows for year-round growing seasons in many parts of the country. Smart farming addresses some of Libya's agricultural challenges like water scarcity. Precision irrigation, soil moisture monitoring, and drip irrigation enabled by smart technologies could significantly improve water use efficiency. Automation and remote monitoring aspects of smart farming address labor shortages in Libyan agriculture. Many farmers are aging and young people are moving to cities, exacerbating labor issues. Smart farms require less manual labor.

Renewable energy technologies integrated into smart farms address power issues in rural Libya. Solar panels, small wind turbines, etc. could provide reliable off-grid electricity for automation. High upfront costs of smart farming equipment and technologies may be challenging for individual Libyan farmers to afford initially. Government incentives or financing programs could help facilitate adoption. Internet and cellular connectivity in rural areas need to be strengthened to support remote monitoring aspects of smart farms.

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