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Corresponding Author
Mohamed M. Fathy Youssef, Department of Electrical Engineering, College of Engineering, Al-Baha University, Albaha, Saudi Arabia On loan from Shubra Faculty of Engineering, Benha University, Egypt

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Design of Solar Power System for Chicken Farm at Saudi Arabia

Mohamed M. Fathy Youssef
Department of Electrical Engineering, College of Engineering, Al-Baha University, Albaha, Saudi Arabia On loan from Shubra Faculty of Engineering, Benha University, Egypt

Abstract
The research aims to study, analyze and design solar power system for poultry to save money in production process. The solar energy sector has neglected the poultry industry for a long time, despite it being a major consumer of electricity, so this project aims to support farmers with electric energy generated by solar energy in order to rely on solar energy solutions. Because of the importance of this project, which focuses on the importance of solar energy in saving costs. This project constitutes a nucleus for the design of an electric power supply system through solar panels to start implementing this program later on at the country level in the Kingdom of Saudi Arabia and it can save a lot of production costs and serve many poultry farms and provide them with clean and free electric energy.

INTRODUCTION

The Minister of Environment, Water and Agriculture in Saudi Arabia, Engineer Abdulrahman bin Abdulmohsen Al-Fadhli, revealed an expansion plan for the broiler sector and support services, in cooperation with the relevant authorities, with the aim of raising the self-sufficiency rate of poultry meat to 80% by 2025 as a first stage to achieve food security.

He said that., the expansion plan will contribute to pumping new investments in the poultry production sector in the Kingdom, with a value of 17 billion riyals until 2025, to achieve a target production capacity estimated at 1.3 million tons of broiler chickens annually and aims to achieve national food security, increase the contribution to local content and provide Jobs chances.

The minister stressed that the financing of the Agricultural Development Fund for companies and institutions wishing to expand the poultry production industry amounts to about 70% of the investment cost when using modern technologies.

He explained that these new expansionary investments come to enhance the role of the poultry production sector in achieving food security and providing local products with high quality and appropriate prices, in direct line with the Kingdom's Vision 2030, which aims to support the private sector, increase its contribution to economic development, and raise its contribution to the output. gross domestic product, according to the Saudi Press Agency "SPA".

It is noteworthy that the percentage of self-sufficiency in poultry meat increased from 45% in 2016 to 68% in 2022 AD, as the Ministry of Environment, Water and Agriculture seeks through its plans, programs, follow-up and technical support; To raise the self-sufficiency rate of poultry meat to 80% to achieve food security[1].

From the above, we find that the Saudi government is moving towards supporting the poultry sectors because of their importance, which prompted many investors to establish private poultry to produce large quantities of chicken. The process of establishing a poultry house requires the presence of electrical devices such as lighting devices and their electrical equipment. Which necessarily required the need for electrical energy. This project presents the idea of providing electrical energy to poultry by solar energy and the mechanism of designing an electrical energy feeding system by solar energy.

Poultry and Solar Power System: Solar power is a clean and renewable energy source, which has been applied to a large number of areas. In this paragraph, we will talk about the poultry-solar system.

Solar energy projects in Saudi Arabia have huge potential, due to their enjoyment of sunshine throughout the year, which supports achieving the goal of producing electricity through renewable energy sources. Investments in this field in Saudi Arabia focus on small commercial and industrial projects, such as small solar energy projects and off-grid solar energy, which are carried out by integrating with photovoltaic energy storage systems in batteries.

With this in mind, the Chinese company Sungro has agreed with the energy provider to build a small network of companies interested in developing in the poultry industry. This small network aims to provide the poultry farm with the necessary electricity through solar energy sources instead of relying on diesel generators and fossil fuels.

The technology of the small grid is based on the use of a photovoltaic solar energy inverter with a capacity of 2,576 megawatts, with an electricity storage system with a capacity of 1 megawatt/3.957 megawatts/hour in the batteries, to provide the electricity needed to operate the poultry farm through solar energy.

The Sun Grow Company in the Middle East and North Africa confirmed that providing the poultry farm project with a system to store electricity derived from solar energy in batteries reflects the importance of sustainable agricultural development and local residents benefiting from small networks without the need for large-scale solar projects[2].

The use of solar energy in a poultry farm, is of great importance, and it is a pioneering project. And that the project of storing electricity derived from solar energy in batteries in the poultry farm is a project that has a great return and reflects positively on the provision of electrical energy, the environment and the health of poultry.

Solar energy is a sustainable solution and battery storage systems are practical solutions based on the integration of units. This technology is available in the area of land, which enhances the ease of its application in not very large areas, as well as making it easier and simpler to transport, install and operate it. Electricity storage systems in batteries for networks of small solar projects are characterized by the simplicity of maintenance procedures, which achieves the highest productivity expected from these projects.

Related Works: This research aims to verify the efficiency and performance of a solar-assisted local heating and ventilation system for raising chickens in a prototype of 16 poultry houses. 3D numerical simulations were performed in order to model the heated space where the convection unit is used to meet heating needs as well as fresh air requirements that maintain ammonia (NH3) and carbon dioxide (CO2) concentrations in the microenvironment. Chicken is less than 25ppm and 2500ppm, respectively, according to published standards. System performance has been analyzed and compared to a fully hybrid heating and ventilation system based on conventional fuels. The results showed that the local system saved 74% of the energy required in the conventional fully mixed system. Moreover, a solar system based on parabolic capacitors was able to cover 84% of the load required for a six-week winter flock[3].

The advantages and limitations of solar photovoltaic (PV) power generation systems are reviewed under various material efficiency limits and financial assistance programs. Recent increases in utility and fuel costs in poultry production as well as public awareness and demand for green energy or renewable energy sources have led to a renewed interest in alternative energy sources. This study seeks to investigate the impact of alternative energy programs, grants, and other incentives on the viability of solar PV systems in several solar energy areas within the poultry industry in Tennessee. Preliminary results show that incentives beyond current levels prior to adoption of solar PV systems would be financially beneficial[4].

Some studies have shown the importance and effectiveness of solar energy systems for supplying electrical energy to poultry. Drawing on data from the US State Department, a US study demonstrated the effectiveness of the energy program and analyzed how and how large the solar system, photovoltaic generation and associated offsets affect the solar system in a representative southeast of a US commercial poultry farm. The results showed the importance of poultry use of solar energy and that the rates of electricity purchases decreased and indicated the size of the system needed to secure the electrical energy of the poultry house through solar energy and the importance of providing solar energy in determining the profitability of the solar system for commercial purposes in poultry farms. And it reduces costs and improves profits[5].

A study[6] showed that in recent years, the great development of renewable energy generations has helped in the acquisition of sustainable energy and environmental goals, although its intermittent and volatile nature has raised challenges against this technology. However, a hybrid power system can reduce these technical issues by incorporating renewable energy sources capable of flexible generation such as biomass. This study[6] deals with the optimization of a biomass-based, grid-integrated hybrid energy system based on biomass to meet the energy demand in a rural area containing poultry farms. Along with solar and wind energy, the integration of energy storage is evaluated with respect to overall technical, environmental and economic performance, taking into account the potential for actual implementation. In addition, sensitivity analyzes are performed, taking into account the estimated load and amplification using the artificial neural network method. The use of biomass and solar hybrid options offers more independent, environmentally friendly and economical advantages. A biomass-based hybrid power system with solar reduced the net current cost by about 12% and increased the renewable fraction by 7% and grid-connected options could provide an 88.9% renewable fraction. Additionally, energy storage integration increased the renewable energy portion by about 10% and reduced excess capacity by 16%. The proposed biomass-based hybrid power system achieves a cost-effective scale for solar or wind-based hybrid systems, enhances renewable energy reliability and provides good coherence to decarbonization goals.

The study[7] showed that by installing 2 square meters of solar collectors, 5.2% of the total solar energy could be saved. To supply the farmhouse with 100% energy with the help of solar energy, with an area of 30 square meters of solar energy. The more solar radiation, the higher the system's ability to generate solar energy. The maximum solar energy production (without energy waste) can be obtained with an area of 26 square meters. To balance the use of solar energy and space needed to design this system.

Step of Research: This message was accomplished in several steps as follows:

Analysis of the poultry with all components, which are:

- A-Determining the equipment for poultry
- b-Determining the amount of power required

Study type of solar system and concentrate on grid on type.

Analysis of the grid on solar system with all components, which are:

- A-Determining load, which may be run and total power
- B-Determine the batteries size and number
- C-Determine the size and number of the solar panel
- D- Controller design for the lighting system.

Proposing design for grid on solar power system for poultry using MatLab/Simulink

Analysis proposed system and getting results.

Poultry and Equipment:

- Poultry Farm Equipment
- Setter

It is a machine in which proper temperature, humidity and turning are provided for the first 19 days of incubating chicken egg.

Hatcher: It is similar to that of setter but turning mechanism is not available and the trays are designed to hold the newly hatched chicks. Here, the eggs are placed for the last three days of incubation. Various styles of setter and hatcher found around the world include:

- Walk-in or Corridor incubators
- Tunnel type incubators
- Vertical fan incubators

Compressed Air System: Some incubators require compressed air to actuate the turning mechanism for the racks of eggs. A large central compressed air system is needed for blowing down dust and other dry cleaning in the hatchery.

Hatchery automation equipments
It includes:

- Hatcher tray washers
- Waste removal systems
- Egg transfer machines
- In ovo vaccination equipment
- Chick box washers
- Rack washers
- Vaccinating/sexing/Grading systems
- High pressure pumps

Egg handling equipments
Hatching Egg Trays: Generally hatching eggs are set in the flats or bug-eye type trays. The capacity of each tray is either 90 or 180 chicken eggs.

Hatching Egg Transfer Machines: This is used to transfer the eggs from the breeder farm trays to hatcher trays. Vacuum egg lifts usually employed in the hatcheries handling large volume of eggs.

Egg Candler: It is a lighting device, used to find out the internal structure of eggs. Two types of egg candlers are available, individual and mass candlers.

Electrical Brooder: It is also thermostatically controlled heating system that spread required amount of heat uniformly above large area, this avoid crowding of chicks under brooder directly. One electrical brooder can be used for 300-400 chicks.

Infra-Red Bulbs: It is a self reflecting bulb and hence no need of reflector over the bulbs. 150 and 250 watt bulbs are available to provide sufficient heat to 150 and 250 chicks, respectively.

Electrical Heaters (Heating Rods or Coils): This type of brooder is provided with heating elements and pilot lamps and in some cases thermometer is provided to record the temperature. They used to have a reflecting device over the heating rods or coils. The temperature can be adjusted depending on the requirement.

Feeding Equipments: Feeders are equipment used to feed the birds, by placing feed in them. They may be conventional, semi-automatic of various designs and shapes and made up of either metal or plastic. Different feeding equipment are,

In case of automatic feeder the feed is supplied to the entire length of the poultry house by specially designed feed troughs with auger type or chain type devices to move the feed from the feed bins to the other end.

These are operated with electricity and the height of the feeder can be adjusted depending upon the age of the birds.

CONCLUSION

In this chapter, the definition of poultry farms and how to invest and spread them. The focus was on the equipment used in it, especially the equipment that needs electrical energy and the equipment that does not need electrical power was not discussed because it is not part of our research project. Where our project focuses on the electrical feeding of the poultry house with electrical energy generated from the sun. From it, it is necessary to know the total capacity of the electrical equipment in the house and this is what has been focused on in this chapter.

Solar System Designed for Poultry
Solar System Types: As the demand and prices of electricity continue to rise, people are starting to look to renewable energy sources for their energy needs. In recent years, solar energy has become a popular source of renewable energy due to its lower costs and improved efficiency. Solar energy is the use of solar energy through various technologies by capturing the heat emitted by the sun. A solar power system is a system that generates electricity by using solar energy. A typical solar system consists of solar panels (which absorb sunlight), an inverter (which converts DC into AC), batteries (to store the additional energy generated), a grid box and balance systems (wires, nuts, etc.). The solar system comes in different sizes like 1kW, 3kW, 5kW, 10kW etc. Generally, the solar power systems can be divided into three types:

- Grid-tied Solar Power System
- Off-grid Solar Power System
- Hybrid Solar Power System

Grid-Tied Solar Power System: This type of solar power system is the most common one. A grid-tied or grid-connected solar power system, as the name suggests is a solar power system that is connected to the home and to the traditional electricity utility grid. This type of solar power system does not include any storage battery. The solar power generated by the solar panels is instantaneously consumed by all the appliances. In case the solar power system is generating more power than the home is consuming, the excess power can be sold back to the utility company under a scheme known as net-metering. When the solar power system is not producing sufficient power, the balance power required by the appliances is drawn from the utility grid. This type of system requires a few panels, wiring boxes and disconnects and an inverter. Also, the user have to make an interconnection agreement with the local utility company.

Advantages

- **Initial Cost:** Purchasing a solar power system for your home can be very expensive. But grid-tied systems are much cheaper since they use less equipment than the other types of rooftop solar power

- **Low Maintenance:** The operating cost of grid-tied systems is very low. Solar panels have 20-25 years of warranty

- **Reliability:** Grid-tied system is simple and have no downtime (without electricity)

- **Flexibility:** You have the chance to design your system with an alternative energy source and a utility source. In this way you can change the system to meet your needs in the future

Disadvantages: The setback of this type of solar power system is that when the sun goes down, user are not able to use any of the energy that the solar panels produce. This can also happen if the electric grid is down; the solar panels will be shut off automatically too, leaving user without energy. This will definitely influence the daily life.

Off-grid Solar Power System: An off-grid solar power system, as the name suggests is a completely independent solar power system with energy storage that is not connected to the main utility grid. The solar panels are the only source of energy in an off-grid solar power system. This energy is either provided to the appliances, or, stored in the battery for future use.

Off-grid solar power systems are ideal for remote rural areas or applications where other power sources are either unavailable or impractical. Off-grid solar power systems can either be AC-based systems, in which case they include an inverter that converts the energy stored in batteries to AC power and feeds it to AC appliances, or, DC-based systems, that are cheaper as they don't need an inverter but the power can only be fed to DC appliances.

This type of system is more expensive because it is bigger since it's not connected to the electric grid. This requires more solar panels and batteries.

Advantages

- **Independence:** One of the best things about this type of solar power system is that users don't depend on the utility company. users are not subject to the terms and policies of the utility company

- **No Blackouts:** Another benefit is that when everyone else has no electricity, the home will still have full power. This is very important to people with health conditions that require electronic devices or refrigerated medicines

- **No Electricity Bills:** Because user is producing his own electricity user will never again have to pay a bill to the utility company

Disadvantages

- **Higher Initial Cost:** If users don't have a connection from the utility company, user will need a backup battery when there is no sun. Adding this source of backup will increase your costs

- **Limited Solar Energy Storage:** If the weather is cloudy or rainy for a few days, user may run out of stored electricity

- **Energy Efficiency is a Must:** user needs to be very careful about the energy, or he may not have enough power for the home.

Hybrid Solar Power System: A hybrid solar power system is a solar power system with energy storage that is similar to a grid-tied solar power system but comes with an energy storage system usually in the form of battery backup. In the last couple of years, this type of solar power system is becoming very popular, even though it's more expensive. When solar energy production exceeds demand, the excess solar power is utilized to charge batteries and stored for later use. When production is lesser than demand, the stored energy from the batteries is used to make up the shortfall.

A well designed hybrid solar power system provides user dual benefits of reducing his electricity bills while also providing user the comfort of having back-up power during a power outage. The hybrid system consists of a PV array, a charge controller, a battery bank and inverter and in some occasions a tertiary power source like a wind turbine or a gas generator.

Advantages

- **Energy Storage System:** If the solar power system produces excess energy, it can be stored in the battery. So even if there is no sunlight, user can still power his home. If there is a power outage, the home will still have power for hours

- **Save Money:** The battery can provide additional opportunities to save money because the energy storage system can make sure user is using its power instead of the power of the grid.

Disadvantages

- **Cost:** The system costs more because user needs to change the batteries regularly. Although the cost of batteries has gone down in recent years, they still need to be replaced at some point

- **High-Level Expertise:** This solar power system is more complex so user may require a solar installer with a higher level of expertise to design and install

These three types of solar power systems all have their own advantages and disadvantages. Customers can accordingly choose the type of solar power system that meets their electricity demand.

Principle of Grid on Solar System: This system works in two-ways-the supply of electricity can flow from the grid to which it is connected to the user's home and from the user's home to the grid. This feature makes the on-grid solar system affordable and highly useful. The solar panels, installed on the user's home are 'tied' to the grid. The solar panels convert sunlight into electric energy, which is Direct Current (DC). This current is then sent to an inverter. The solar inverter then converts the DC to Alternating Current (AC), thus making it power the electrical items. This electricity is then routed to the grid where it is supplied for day to day use. The grid tied inverter additionally regulates the amount and voltage of electricity fed to the household since all the power generated is mostly much more than a home needs or can handle. An important feature is the net meter. It is a device that records the energy supplied to the grid and the energy consumed. At the end of each month, the outstanding is recorded and the consumer is provided with a bill. This 'converted' power supply is then used by homes through the main electricity distribution panel.

Solar Energy Design and Implementation Details: Off-grid energy infrastructures, also referred to as "microgrids," are a non-conventional form of power generation that are becoming more and more popular for off-grid design and/or anyone concerned about grid stability. They work independently or in conjunction with the grid in order to reduce stress on existing infrastructure while strengthening grid resilience. Some of the advantages of microgrids are:

- Enhanced Reliability-They mitigate grid disturbances
- Efficiency of Delivery-They reduce energy losses in transmission and distribution
- Reduced Per-unit Cost-They bring down the cost of energy production

The concept of microgrids could be an energy game changer because they decentralize the conventional power system model. Every power system involves generation, transmission and distribution. But in the case of microgrids, power is generated as close as possible to the distribution end. Thus the term "distributed energy resources" (DERs).

DERs are typically renewable sources of energy, the most widely used being solar and wind. These sources are readily available and among the most efficient sources. When part of a microgrid, they also offer always-on power through multi-mode backup options like grid-connection and/or backup generators, avoiding the sometimes significant expense of power outages.

Power to be produced/generated is determined as a total of load demand (how much power is needed by equipment) and losses incurred (how much power is lost by equipment, wiring, etc).

Generation = Load Demand+Losses: This is the conventional method of determining power production. With both a conventional grid and an off-grid (or grid-tied) microgrid, losses are categorized into fixed (guaranteed to happen) and variable (dependent upon system design). They occur due to heat dissipation.

Fixed losses would be:

- **Unwanted Heating of Resistive Components:** The heating of resistive components caused by stresses on equipment and accounted for based on equipment specifications

- **The Effect of Parasitic Elements Such as Resistance, Capacitance and Inductance:** The losses experienced within the circuits themselves and based on system requirements.

- **Skin Effect:** Accumulation of charge on the surface of the conductors

- **Losses within the Transformer:** Eddy currents, hysteresis, unwanted radiation, dielectric loss, corona discharge, etc

- **Eddy Current:** a localized electric current induced in a conductor by a varying magnetic field

- **Hysteresis:** In this condition the magnetic induction lags behind the magnetizing force

- **Dielectric Loss:** This value quantifies dielectric (insulatory) materials' inherent dissipation of electromagnetic energy mainly in the form of heat

- **Corona Discharge:** This condition is observed as a glow around a conductor at high potential mainly due to ionization of air

- **Transmission and Distribution Losses:** These are due to lengthy lines, conductor sizing, unbalanced systems, low power factor, load factor, overloading of lines, distance between distribution transformer and load center, etc

Variable losses would be:

- Maintenance, expected and unexpected outages, energizing of equipment during peak and low demand hours, etc

Note: *As mentioned before, microgrids are installed on the distribution end-meaning installation and power collection happens where the power is needed. Thus, transmission losses are negligible.*

In case of a solar microgrid, the concept to determine the power generated is the same as a conventional grid: load+losses. The method and technical terminology used will be different though with a microgrid. This is because we are working with solar panels, batteries and inverters rather than traditional-grid generators, transmission lines, etc.

With a microgrid based on renewable, intermittent solar power, the following terminology is helpful to understand (and different from) a traditional grid-tied system:

- **Insolation and Shading of Location:** This term refers to the amount of solar radiation reaching a given area

- **Capacity Factor:** The ratio of actual power generated over a year by the installed capacity

- **Storage System:** Energy savings produced at one time for use at a later time. In the case of microgrids, deep cycle batteries are our recommendation

- **Inverter Losses:** This term depicts the efficiency of the inverter. Efficiency varies according to power used at the time and is generally greater with increased power utilization. An inverter uses some power from batteries even when it is not delivering any AC output, resulting in low efficiencies at low power levels

- **Conductor Sizing:** The size of the conductor plays a major role in the system losses. The resistance of the conductor decreases as the radius of the conductor increases. This is observed in the formula for resistance (R) in terms of resistivity (?), length (L) and radius (r) of the conductor:

$R = pL/\pi r^2$: Low resistance in turn, reduces the system losses. System losses are directly proportional to the conductor Resistance times Current (I) squared through the conductor as the constant factor:

System Losses = $R \times I^2$

- **Efficiency of Charge Controller:** Charge controllers regulate the voltage and current coming from the solar panels going to the battery. This helps prevent the batteries from overcharging. Therefore, their efficiency varies based on the battery charge

- **Solar panel I-V Characteristic Curves:** demonstrate the current and voltage (I-V) characteristics of a particular photovoltaic (PV) cell, module, or array and give a detailed description of its solar energy conversion ability and efficiency. Knowing the electrical I-V characteristics (more importantly Pmax) of a solar panel is critical in determining the device's output performance and solar efficiency

The I-V graph below gives a detailed explanation of parameters to observe while determining the solar panel.

Important parameters noted from the above I-V characteristic curve are:

- **VOC = Open-Circuit Voltage:** This is the maximum voltage that the array provides when the terminals are not connected to any load (an open circuit condition). This value is much higher than Vmp which relates to the operation of the PV array that is fixed by the load. This value depends upon the number of PV panels connected together in series

- **ISC = Short-Circuit Current:** The maximum current provided by the PV array when the output connectors are shorted together (a short circuit condition). This value is much higher than Imp which relates to the normal operating circuit current
- **MPP = Maximum Power Point:** This relates to the point where the power supplied by the array connected to the load (batteries, inverters) is at its maximum value, where MPP = Imp x Vmp. The maximum power point of a photovoltaic array is measured in watts (W) or peak watts (Wp). The Maximum power point trackers are programmed to tilt the panels according to the position of the sun during the day based on the MPP (= Imp x Vmp) value.

System Design and Equipment: A typical off-grid PV solar system looks like the figure below:

Here are descriptions of all the equipment seen in the figure above:

- **PV Module:** These modules help convert sunlight (solar energy) to DC using the concept of photoelectric effect on PV cells, which are nothing but p-n junctions

- **Technical Jargon Explanation of a “p-n Junction”:** A p-n junction or diode is a boundary or interface between two types of semiconductor material, p-type and n-type, inside a single crystal of semiconductor. The “p” (positive) side contains an excess of holes, while the “n” (negative) side contains an excess of electrons

- **Solar Charge Controller:** Solar charge controllers aid in implementing two kinds of control:

- Tracker control, also referred to Maximum Power Point Tracking (MPPT) of the panels and

- **The State of the Battery:** Battery State of Charge (SOC) and Depth of Discharge (DOD).

- **Inverter:** Semiconductor equipment that helps convert DC power produced at the panels to AC to meet the load demand

- **Battery:** Solar being an intermittent source of energy (only available when sunny), can be used to charge batteries that help meet the load demand in cases of insufficient or absent sunlight for solar

- **Load (AC and DC):** Appliances connected to the system act as load. Most residential loads require AC. The use of DC is seen in charging batteries with the help of DC-DC converters. In our design we run a DC backbone of 24V for the converters implemented in control and automation

- **Auxiliary Energy Sources/Local Backup:** This source is to act as a substitute for the primary source of energy, which in this case is solar. For this particular microgrid
- infrastructure we decided to go with grid on.

Solar Sizing: Highest Good society, fulfilled living, enriched life, enriching life, living to live, how to live an enriched life, keeping it all running, sustainable living, social architecture, fulfilled living, thriving, thrivability, emotional sustain ability, the good life, a new way to live. The sizing of each equipment component in the grid on solar system design is calculated from the base data for total consumption.

In our case, the system design is an intertie, so the initial system is based on the calculated consumption of the Poultry Farm Equipment's Center combined with that of the farm. Additional expansion will also occur with the construction of farm, but the initial solar setup will provide all the power needed for the Poultry Farm Equipment's Center and farm we food infrastructure.

With our own system as an example, we discuss here the details of sizing a solar system with the following sections:

- Foundational Calculations
- Inverter Sizing
- Battery Sizing
- Charge Controller Rating
- Additional Factors Affecting Equipment Selection

Foundational Calculations: The first step for calculating the solar-sizing specifics is to identify the total power consumption. Total power and energy consumption = Total watt-hours/day (Wh/d), so the total consumption is the sum of individual equipment consumption in the Poultry Farm Equipment's Center.

The next step is to determine the equipment sizing. For this, you will need the rating of the PV module. The PV rating can be found by taking into consideration two factors: losses and insolation. The standard number used for “losses” is about 30%, and this accounts for dust on the panels, indirect sunlight losses, etc. Taking this into account, a loss factor of 1.3 is included in the total power demand so total power produced = 1.3 * Total Wh/day.

S"Insolation" is known as the amount of solar radiation reaching a given area and is expressed in kilowatt hours per meter squared per day (kWh/m2/day) and varies site-by-site. To determine this value, NASA has a detailed database providing the monthly insolation for any site input based on its latitude and longitudinal coordinates. An average of all months is then taken.

Once you know total watt hours and (average) insolation values, use this formula to find the Total watt Peak Rating:

Finding the size of your complete solar array/modules is then accomplished using the Total Watt Peak Rating (provided above) divided by the Rated Output Watt-peak of the module. The Rated Output Watt-peak of a module is acquired once the model of PV panel is decided (Factors Affecting Equipment Selection below) and then this formula is applied:

Note that the number of PV panels is always a whole number. Therefore, irrespective of the solution, round the value to the next highest integer.

Inverter Sizing: As mentioned above, inverters are the equipment that help convert DC power produced at the panels to AC to meet the load demands of all the standard equipment in the building(s), which is all AC powered. This is important because DC power will not power this equipment.

With this in mind, input rating of the inverter is selected so it is greater than the total power consumed by all the connected appliances. This value is typically 25-30% more than the total power consumed by the appliances. This 25-30% addition assures needs are met even during the most extreme energy demands, assuming to never exceed 25-30% beyond your calculated maximum.

Battery Sizing: As mentioned earlier, batteries come into the picture in case of insufficient power or absence of solar. Battery-sizing is necessary for on-grid solar PV infrastructure. Solar PV systems typically require deep cycle batteries. These batteries have an advantage of rapidly charging and discharging to a low energy level, making them highly efficient. Batteries are rated in Ampere-hours. To find the Ampere-hour rating for a given solar PV system calculate the per-day consumption of appliances in watt-hours. The standard loss in batteries is typically 20%. This accounts for the charging and discharging cycle losses. Taking this into account, a loss factor of 1.2 is included in the total power supplied = 1.2 * Total Wh/day.

Draining batteries completely is not advised as it decreases their lifespan. The Depth of Discharge (DOD) should not exceed 60% of the charge. This means the battery can be discharge till 60% of its energy has been delivered. Maintaining this helps increase their lifespan.

Taking into account 60% of the delivered energy, a factor of 1.6 is included in the total power supplied by the battery = 1.6 x 1.2 x Total Wh/day. The nominal DC voltage of a battery is the same as that set for the inverter. Considering economic and technical factors we have set the nominal voltage at 24 V, as further explained in the controls section. For any on-grid Solar PV System it is not advisable to charge and discharge the batteries every day. The "days of autonomy" designs the battery rating based on number of days the batteries deliver power without a charge.

Now that we have all the parameters required to calculate the Ampere-hour rating of the battery, the following formula is applied:

Charge Controller Rating: Charge controllers increase efficiency and lifespan of the batteries and the technology implemented in these controllers continuously evolves. We considered two factors in their design rating:

- The type of charge controller-Available in series and parallel
- The I-V characteristics of the solar panel

Relative to the I-V characteristics, the charge controllers are set at a rating of 1.3 x The Short Circuit Current. This procedure is implemented in the excel sheet where there is a detailed analysis of the cost estimates.

Additional Factors Affecting Equipment Selection: Here are additional considerations to include when selecting equipment. We will add more if our experience purchasing and installing our system reveals anything beneficial.

Solar Panels: Three variations of solar panels are generally utilized for residential and commercial purposes: monocrystalline, polycrystalline and thin film. They vary in silicon content, efficiency, area required and cost, with preference given to the latter two.

Inverters: The calculations for inverter sizing help decide the inverter to be chosen. Cost and the project budget aid in choosing an inverter as well.

Batteries: As previously mentioned, deep-cycle batteries are preferable for PV systems., other factors include price, capacity and voltage.

Following the above-mentioned procedures, these figures were obtained for the sizing of the PV system equipment for the grid on solar system.

Maintenance and Control: While this system is designed as largely automatic and self-sustaining, there will be one or more designated maintenance and service personnel for the community. This person will be in charge of system operations and trained to troubleshoot all aspects of the system. Additionally, a great deal of system automation is possible with the Sunny Islands components. As battery charge drops to critical levels, the Island can initiate start-up of backup generators and/or shut down selected loads (the hot tub for instance).

Routine maintenance includes cleaning PV arrays, securing battery cables and monitoring the Multi-Cluster for any warnings or problems. For this reason, someone dependable and knowledgeable will be “in charge” of the system at all times. When our maintenance plan is completed and tested, we’ll add here the maintenance schedule, video tutorials for all maintenance processes and anything else we believe to be helpful.

Cost Analysis: SOLAR POWER is generating interest among poultry producers as rising costs for electricity combine with lower prices for installations, making for a more attractive proposition.

Prices for solar systems are more than 80% lower than they were ten years ago.

The typical energy requirements of a broiler shed on average would require 80-150,000 kWh of electricity per year,” it is explained. “We aim to size the solar system correctly so that as near as 100% of the solar power produced can be used on-farm.”

A basic comparison is that the average price for electricity in a commercial setting is 15p/kWh. At the same time, after the initial investment and installation, the cost of producing solar energy is 3p/kWh.

“A recent proposal went to a client of ours based on a 50kW system with an investment spend of £30,000.

“The net benefit within the 25 years was over £400,000 with a year-on-year return on investment of over 30%,” said researchers.

For Maintenance: One critical thing to factor in is the ongoing maintenance and what guarantee is offered from the installation company. “We only buy solar panels with a 25-year guarantee,” explained researchers. He added that would-be buyers should check the service package offered with any sale. Vencomatic, for example, has a network of service engineers across the country that can deal with any issues.

Over the life of a solar installation, a farmer should expect to replace the inverter-which typically has a warranty of 10 years.

` Annual cleaning is usually also recommended, depending on the pitch of the roof.

Implementation and Results

Introduction: In this chapter, we will present the practical design of a domesticated feed solar system. Where simulation was carried out using Matlab software. The performance of each component of the solar power system has been simulated. The output of each stage of the work of the solar energy system designed to provide electrical energy for the poultry farm was also known. No part was neglected and alternating and continuous loads were taken into account. Where Simulink is a MATLAB-based graphical programming environment for modeling, simulating and analyzing multidomain dynamical systems. Its primary interface is a graphical block diagraming tool and a customizable set of block libraries. It offers tight integration with the rest of the MATLAB environment and can either drive MATLAB or be scripted from it. Simulink is widely used in automatic control and digital signal processing for multidomain simulation and model-based design. Figure (4-1) shows an example for model in matlab/Simulink.

Implementation: The implementation for project is simulated using matlab/simulink like shown in figure (4-2). It is full model of solar power system for poultry farm, that is consists of the following components:

- PV sub model
- Charge controller
- Batteries
- Inverter
- AC loads in poultry farm
- DC loads in poultry farm

RESULTS AND DISCUSSIONS

PV Sub Model: PV model simulates real PV performance, that is converting sunlight to DC currents with[16-18] V. it is about 17v as average like the one it is shown in (fig. 4-3). This power is transited to charge controller. The output of PV solar panel is voltage with

Fig. (1.1): Solar power system for poultry.

Fig. 2.1 Setter for chicken farm

Fig. 2.2: Hatcher for chicken farm

Fig. 2.3: Auto-hatcher for chicken farm

Fig. 2.4: Transfer machine used in chicken farm

Fig. 2.5: Candler machine used in chicken farm

Fig. 2.6: Electrical brooder used in chicken farm

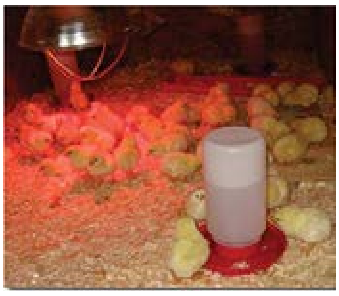

Fig. 2.7: Infra- red bulbs used in chicken farm

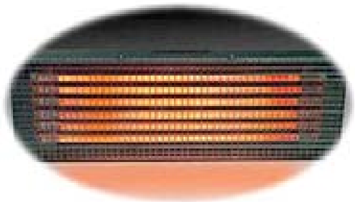

Fig. 2.8: Electric heater used in chicken farm

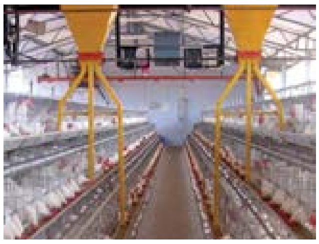

Fig. 2.9: Automatic Feeder used in chicken farm

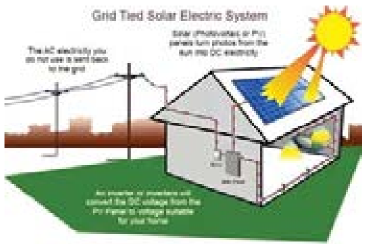

Fig. (3-1): Grid on solar system

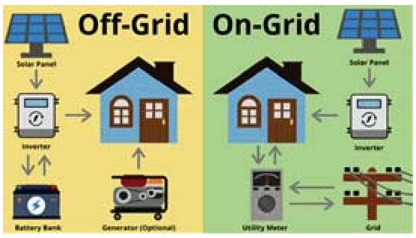

Fig. (3-2): Grid off/on solar system

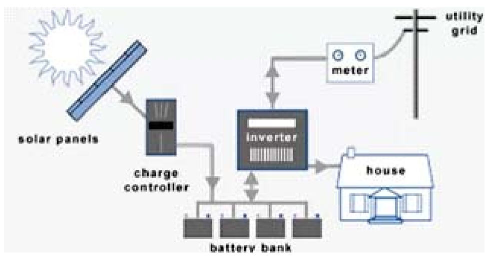

Fig. (3-3): Hybrid solar system

Fig. (3-4): Flow power in grid on solar system

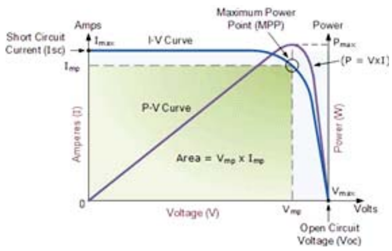

Fig. (3-5): I-V curve for solar power system

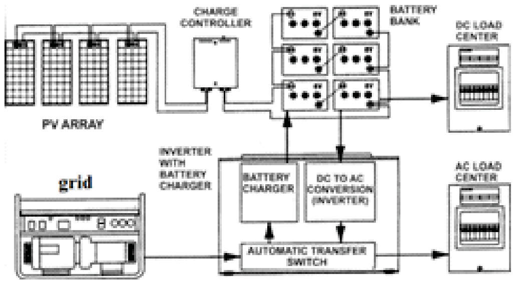

Fig. (3-6):Block diagram for grid on solar power system

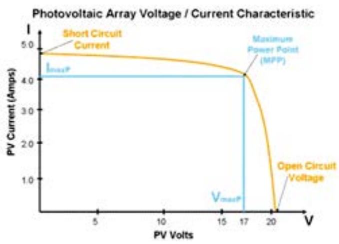

Fig. (3-7): The I-V characteristics of the solar panel for grid on solar power system

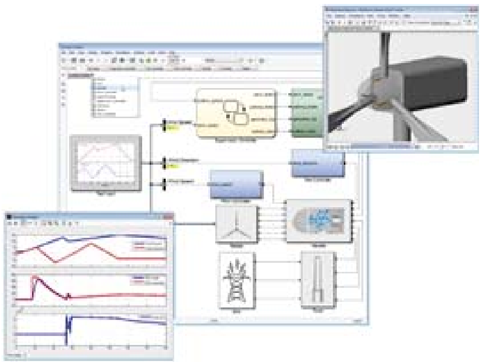

Fig. (4-1): Example for model in matlab

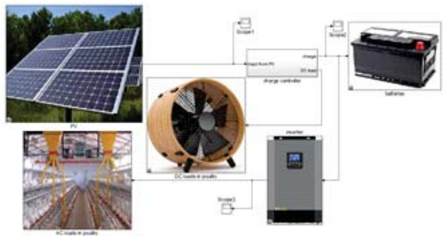

Fig. (4-2): Solar power system model for poultry in matlab

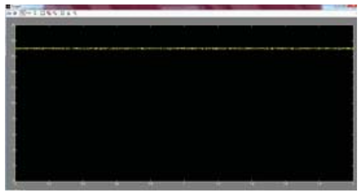

Fig. (4-3): Output of PV in solar power system model for poultry in matlab

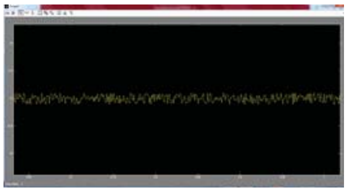

Fig. (4-4):Output of PV in solar power system model for poultry in matlab (Zoom view)

Fig. (4-5): Output of batteries in solar power system model for poultry in matlab

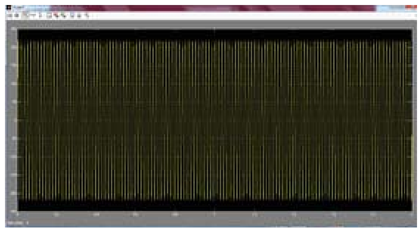

Fig. (4-6): Output of inverter in solar power system model for poultry in matlab

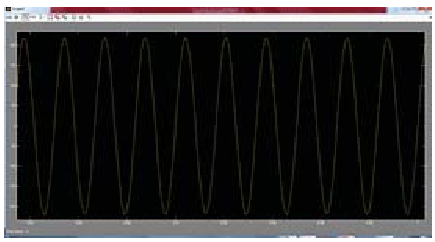

Fig. (4-7): Output of inverter in solar power system model for poultry in matlab (Zoom view)

Table 1: Solar penal sizing

Total demand	283.82	kW	
Consumption per day	4569.92235	kW/day	
Peak demand	150	kW	
Insolation level	4.46	kW/m2/day	peak sun hours/days
Annual days	365		
Annual consumption	1668021.658	kW	
Annual peak sun hours	1627.9	Hours	
Efficiency of system	75%		
Panel wattage	250		Watt
panel size	1.5		Sq meter
No. of Panels required	5465		Nos
Area required	8197.5		Sq meter

Table 2: Battery sizing

Battery sizing	3900.9	kW/day	consumption per day peak demand insolation level
Battery run time (for 3 days)	25746	kW	
Depth of discharge	50%		
Losses	10%		
Bus voltage (V)	24		
Battery rating	1072.75	kAh	

tolerances like shown in (fig. 4-4), which show the voltage output in zoom view.

Charge Controller: Charge controller receives the power from PV and it regulates it to be reformed as 14v with DC current, which is suitable for charging batteries, the (fig. 4-5) shows the output of charge controller. It should be noted that charge controller has two outputs., one of them is for charge of battery and the other is for DC loads in poultry farm like fans that is used to.

Batteries: Batteries are considered bank of power, which is used to storage power. Power is regulated by charge controller, then it transited to batteries to storage.

Inverter: Inverter is used to convert DC power to AC power, which is 60Hz in the Kingdom of Saudi Arabia like shown in (fig. 4-6), which shows the output of inverter used in solar power system. The (fig. 4-7) shows output of inverter used in model for poultry farm in zoom view.

AC Loads in Poultry Farm: AC loads are many in poultry farm like heater and some lamps and eggs collector, which are explained in chapter 2. They are powered from output of inverter.

DC Loads in Poultry Farm: DC load are little in poultry farm like led lighting and fans. They are powered from battery.

CONCLUSION

In this research, the importance of livestock and the aspirations of the Kingdom of Saudi Arabia to reach self-sufficiency in poultry were defined. This prompted many investors to establish poultry houses. And to show the importance and the need of poultry for electrical feeding which constitute additional costs to production. Which highlights the importance of the project, which is to secure the electric power for these poultry houses through solar panels. Which is reflected positively on production costs.

Finally a full model of solar power system for poultry farm is simulated using matlab/Simulink. This model is consists of PV solar panel, charge controller, batteries, inverters, DC loads of poultry farm and AC loads of poultry. All results are carried out to show the output signals for every stage of operating model.

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