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HYBRID PHOTOVOLTAIC ELEMENTS AND THEIR EVOLUTION FOR THERMAL APPLICATIONS

M. Papoutsidakis
Dept. of Automation Engineering,
Piraeus University of Applied Sciences,
Athens, Greece

D. Piromalis
Dept. of Automation Engineering,
Piraeus University of Applied Sciences,
Athens, Greece

E. Symeonaki
Dept. of Automation Engineering,
Piraeus University of Applied Sciences,
Athens, Greece

D. Tseles
Dept. of Automation Engineering,
Piraeus University of Applied Sciences,
Athens, Greece

ABSTRACT - The present work deals with the analysis of photovoltaic and in particular the category of hybrid photovoltaic systems. The first chapter refers to the Solar Energy and specifically the way it can be exploited in Greece by photovoltaic. In the same chapter there is an extensive report on the operation of the photovoltaic cell and the definition of the solar pond. The second chapter presents the photovoltaic phenomenon as well as the photovoltaic structure and types of photovoltaics. It also describes how they work. In the third chapter there is an extensive reference to the photovoltaic types, while the fourth chapter analyzes the hybrid energy generation systems. In the fifth chapter there is a comparison between the photovoltaic systems and the conventional ones. The following section describes the required conditions for the installation of a photovoltaic system and the placement installation. The seventh chapter encompasses the use of photovoltaic applications in industrial and agricultural sectors and buildings. Finally, we present the conclusions of the paper and the bibliography.

General Terms
Your general terms must be any term which can be used for general classification of the submitted material such as Pattern Recognition, Security, Algorithms et. al.

Keywords
Keywords are your own designated keywords which can be used for easy location of the manuscript using any search engines.

I. INTRODUCTION
Renewable Energy Sources refer to sources of energy that are the result of various natural processes (Aeolian, solar, geothermal, hydraulic, biomass). Their main characteristic is that they are replenished constantly and are eco-friendly, serving various purposes on multiple sectors. One of the many ever- evolving technologies of RES is the photovoltaic system, which is used for the direct conversion of solar energy to electrical or thermal.

II. PHOTOVOLTAICS AND SOLAR ENERGY
The conversion of solar energy to electrical is achieved by using photovoltaic cells, of which the function relies on the principle of the photovoltaic effect.

Photovoltaic cells are crystal diodes that are made up by semiconductors with photoconductive properties. The use of silicon is the most common, since it is quite inexpensive and therefore used for the construction of semiconductors [1]. Theoretically, a common photovoltaic cell can absorb around 25% of the energy that reaches it. Practically, though, the most common percentages noted are less than 15%.[2]

Figure1: solar panel

2.1. Solar pond
Solar pond is an economical solar collector which uses the water as a form of a cover. The pond's bottom layer salinity percentage is kept at certain level, so as it can remain heavier than the layers above it, even if it receives large amounts of heat. This way, high temperatures are achieved to the bottom layer of the water and a large percentage of the solar energy can be stored without any noticeable thermal losses. [3]

2.2. The Photovoltaic effect
Photovoltaic effect is the conversion of a part of the visible spectrum of sun's solar radiation into an electrical type of energy. During the light emission, a

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lot of electrons get a higher energy level by absorbing the energy of the photons.

2.3. The structure of photovoltaics

The photovoltaic arrays may be stable or rotary. In order to amplify the percentage of the radiation reaching the system, their design may include the use of reflectors, Fresnel lenses or mirrors.

III. TYPES OF PHOTOVOLTAICS

The application of photovoltaic systems is wide and one of the main factors of which one will be chosen is the required power supply. The photovoltaic systems are divided into two larger categories. [4]

3.1. Isolated or otherwise photovoltaic systems off network

Isolated or otherwise photovoltaic systems off network, where the power supply fluctuates between 100 Wp to 200 kWp. The isolated photovoltaic systems may be autonomous or hybrid. In the first case, the required amount of energy is produced only by the photovoltaic arrays and can be given directly for consumption or stored with the help of accumulators.

In the second case, the hybrid photovoltaic systems combine other sources of energy, apart from the solar, which may be conventional or renewable. Generally, they use an electrical power generator or even a wind turbine. The hybrid photovoltaic systems are used when the required electrical energy cannot be covered by the autonomous, for example for the operation of a monastery or a vacation house. [3]

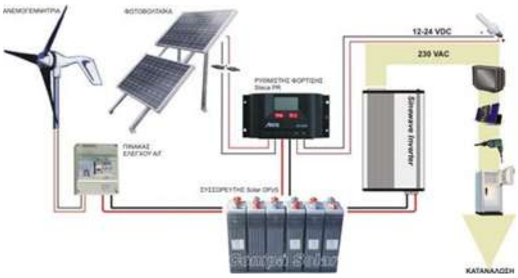

Figure 2: hybrid system for residence

3.2. Photovoltaic systems connected to the network

Photovoltaic systems which are connected to the electricity network get from it the required power supply that cannot be covered. As a result, there is no need for storage of the electrical energy produced. Depending on the design of the system, the network can operate not only as an auxiliary source of energy, but also interact with it. In the second case, the system is capable to cover the energy requirements of the application throughout the year. Ideally, it can produce same or maybe even more amounts of energy than the percentage of energy headed from the network to the application.

Figure3: Cestas photovoltaic park, connected to the network

IV. PERFORMANCE OF THE PHOTOVOLTAICS

The level of performance of each type of photovoltaic occurs by the ratio of maximum electrical power Pmmp to the product of surface A of the photovoltaic element and solar radiation G.

$$\eta = \frac{P_{mmp}}{AG} = \frac{I_{mmp}V_{mmp}}{AG} = FF\frac{I_{sc}V_{oc}}{AG} \quad (1)$$

This performance will always be less than the theoretical performance occurring by the equation.

$$n_{max,th} = \frac{\varphi(E_g)V_m}{\varphi E_\mu} \quad (2)$$

Where φ(Eg) is the flow of photons with lots more energy than the energy gap of the semiconductor, Φ the total flow of photons received by the photovoltaic element and Eμ the average energy of the radiation photons.

4.1. Factors that influence the level of performance

The factors influencing the performance level of the photovoltaic are divided into two categories; the internal and the external factors [5].

The internal factors refer to the construction characteristics of a photovoltaic element, such as the resistance, its' aging, and the reversed diode. The external influencing factors are the solar radiation, the temperature of the environment, the intensity of the wind, the percentage of shading on the plates, the percentage of atmospheric pollution and the totality of electrical losses.

Aging factor; The aging factor refers to the decrease of the performance of a photovoltaic after several years passed, which is mainly due to the overheat of the photovoltaic cells which alienate their structure.

Optical energy losses; these losses have to do with the performance's deviation when we compare it to the standard condition's performance. This might happen due to:

-differentiation between PV panel's reflectivity and Standard Test Condition's (STC) reflectivity.

-the fact that solar radiation spectrum differs from the air mass might affect

the system.

- Losses due to polarization's differentiation.

-Losses due to low solar radiation's density

-How clean is the PV module's surface

PV cells' temperature; In standard tests the PV panel's functioning temperature is different than the actual one, so the actual PV panel's performance will be different than the STC.

V. GENERAL PHOTOVOLTAIC TYPES

Generally, the photovoltaic element is square with a 120-160mm sole side. Depending on the material and their design, photovoltaics may have several types: Films (6-8% performance) single crystal silicon (15%), poly crystal silicon (12%) and no-form silicon (6%) [6].

5.1. Photovoltaic Thermal Collectors (Pvt)

Photovoltaic thermal collectors produce electricity and heating at the same time.

By using water and/or air, the PV module cools down and therefore its performance is improved. The air or water that is used for the PV'S heat extraction becomes warmer, so it could be used to cover the building's thermal needs.

There are three main types of photovoltaic thermal collectors; PVT water collectors, PVT air collectors, combination water/air PVT collectors.

These types of PVT collectors use different manufacturing design, depending on the needs of the system. The most common design for PVT water collector is the "sheet and tube", where a water tube absorber is placed under the single or double glazed PV module, into an insulation material. PVT air collectors (single or double pass design) use the air flow to cool down the PV module.

The type of PVT collectors that is most commonly used is thermal collectors that combine air and water. There are three kinds of these collectors, depending on which way the fluid/air flows: Channel, free flow and two-absorber.

As we mention before, the conventional cooling of the PV panel could be achieved through air or water. The choice between air and water depends on the needs of the system, as well as the weather conditions.

The collector and the water tubes can be placed behind the module, either in the middle of the vent or at the vent's insulation area. This is a simple form which could be applied in buildings 's faces and roofs, at industrial or agricultural field. [4]

5.2. Hybrid systems

A hybrid energy system is a system that can combine two or more types of technology (renewable or not) that produce energy. For example, concerning renewable energy sources, it could use photovoltaic air turbines. As for the conservative technologies, diesel generators can be used. The system will operate way only when there is a higher energy demand or when there is a low renewable energy sources potentiality. For that reason, hybrid systems functioning with fuel related technology are the ones who operate with the least consumption.

The factors that should be taken into consideration when we design a hybrid system are the following: [1]

- The place where the system will be set up, as well as the load's general characteristics. (kwh, peak).
- Availability and percentage of every renewable source's possible exploitation.
- Technology growth as regards the system's construction and function.
- Total building, operation and maintenance expenses
- The system's impact to the environment.
- National policy regarding the use of the hybrid energy producing systems

It could be said that hybrid systems can be developed either as autonomous and independent within systems distributing energy, or as thermal units based on diesel fuel. Depending on the system's design and application needs, several modifications might be required.

5.2.1. Hybrid Photovoltaic systems

Solar radiation is received by the photovoltaics and only a small percentage of it is converted to electrical energy, while the rest is dissipated into the environment in the form of heat. While the photovoltaic system operates, its' performance decreases due to their increased temperature. The system can be cooled down by using a liquid which results to the transfer of the heat from the photovoltaic to the liquid so as the thermal needs of the building are covered, achieving at the same time a higher electrical performance and a reduction on thermal losses. This process is called operating principle of hybrid systems [7]. The main goal of hybrid photovoltaic systems is the maximum exploitation of the solar energy with as little losses as possible.

5.3. Cooling process of the photovoltaics

The hybrid photovoltaic systems consist of the photovoltaic panels which have an embodied thermal gain unit of the photovoltaic. In this thermal gain unit, there is a type of liquid which presents a lower temperature than the one of the photovoltaic circulates. This liquid is getting warmer while cooling down the unit. The systems are divided into two large categories [8].

-water photovoltaic systems

-air photovoltaic systems

The use of water as a liquid which will receive the heat is well performing, especially in the region of Greece, a place well known for its' mild and warm climate. These hybrid layouts are used in order to warm up the water in even lower temperatures and cool down the PV panels.

If the panel 's heat is abducted through air, then a simpler layout is needed, which means reduced cost in comparison with water photovoltaic systems. They are inexpensive but their performance is not that good. When the atmospheric air reaches a temperature higher than 20 Celsius degrees these photovoltaic systems present less productive abilities.

5.4. Cooling with the help of centralized photovoltaics

In this way, all centralized flow will "hit" the photovoltaic cell resulting to the production of a percentage of electrical energy. The total of this produced thermal energy will penetrate the cell with the help of the saddle and afterwards it will flow through the heat pipe, distributing eventually from each heat pipe to a total of fins where it will be extracted with natural transmission.

Figure 4: Photovoltaic example

The process of cooling down is achieved with the physical transmission of heat, while obligatory transmission requires the use of a fan, which causes the reduction of the total performance of the system since the fan requires energy in order to function properly.

VI. CONCLUSIONS

After studying and analyzing photovoltaic systems, we can conclude that there are several categories of photovoltaics, depending on existing needs. Greece is a country characterized by extensive sunshine, therefore the use of photovoltaics could prove beneficial not only for the economy but for the decrease of environmental pollution as well. Application of photovoltaics is necessary for places distant and isolated from the main electricity network or islands. Their energy problem could be solved by developing and using photovoltaic systems.

Hybrid systems could make the most of the characteristics of each technology, offering sizeable amounts of energy. For example, they can produce 1Kw to hundreds of kw, quantity comparable to the energy produced by the electricity network.

A hybrid system can be used to a region where its' connection to the electricity network or fuel transportation are expensive options. Furthermore, they offer the privilege of being able to connect to a future network of the region in which the installation is being done. Finally, because of their high performance and their reliability, they are really effective concerning offering power supply to consumers/customers that are specialized (ex. Hospital units) or in case of a black-out.

Something worth mentioning is that hybrid photovoltaic systems are nowadays a really good choice since they operate in harmony with the environment and are also trustworthy, have a life expectancy and can operate under any weather condition. Hybrid systems are an under development type of energy and it is optimistic to say that in the future, their increasing use will result to their evolution and capability to meet higher energy requirements.

In conclusion, it could be said that in Greece, the RES sector is rapidly evolving. European Union has the following ambition; By the year 2020,20% of the demanded consuming energy will come from renewable energy sources [9].

Despite of any existing suspensory factors, the future of energy can be perceived as optimistic. Studies and interest concerning the use of photovoltaics` is growing, which will lead to an increased use of them during the course of the years.

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VIII. REFERENCES

[1] Mamasis (2010). Introduction to solar technology;" Solar energy and photovoltaic systems'', Lectures, aqueous resources area, National Technical University of AthensDing, W. and Marchionini, G. 1997 A Study on Video Browsing Strategies. Technical Report. University of Maryland at College Park.

[2] Perdios, S. (2010). Photovoltaic installations, SELKA-4M Publishing, Athens

[3] Apergis, N. Payne James E. (2010). Renewable and non-renewable energy consumption growth nexus: Evidence from a panel error correction model, vol (73), pp (733–738).

http://www.sciencedirect.com/science/article/pii/S0140988311000909.

[4] Apostolopoulou, A (2013) Complex photovoltaic and thermal devices' layouts. Physics Department, University of Patras

[5] Tsiligridis, G.(2008B) Educational notes; Management of energy resources. Mechanical engineering department, Aristotle University of Thessaloniki.

[6] Fragiadakis, I. (2009) Photovoltaic systems. Third edition, Ziti publishing, Thessaloniki.

[7] Charalampopoulos, G (2009). 'Ecobuilding: Photovoltaic systems. Bioclimatic design of buildings and renewable energy sources' applications'. Psichalou Publishing, Athens.

[8] Yean Gan, P. και ZhiDong, L. (2015). Quantitative study on long term global solar photovoltaic market, vol (46), pp (88-99). http://www.sciencedirect.com/science/article/pii/S136403211500129X.

[9] Bitzionis, D.B (2011). Alternative Energy Sources, Tziola Publishing, Athens.