Control Systems for Solar Energy Conversion

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Abstract - The electricity generated from renewable sources is becoming more available. The choice of such renewable energy sources for consumers to support the development of clean energy that will reduce the environmental impacts associated with conventional energy generation and increase energy independence. To increase the efficiency of a photovoltaic panel that is facing the sun agreed, thus achieving a system for tracking the position of the sun. Via a preprogrammed trajectory to have the sun according to the hours of the day.

Key-Words: - Photovoltaic panels, Transfer function, Optimization.

1 Introduction

Green energy is a term that refers to renewable energy sources and clean. Furthermore, when these technologies can come to help consumers by reducing bills for various utilities (water, heating) and a short payback time for domestic water heating systems, adoption of such a system is an investment extremely cost for households, hotels, hospitals etc. Photovoltaic and wind energy are viable solution for buildings that do not currently enjoy the national electricity network connection [10]. In the future, by appropriate legislation such systems can become cost effective for customers connected to the national network by eliminating the need of using batteries and supply power directly to the national grid. Renewable energy potential and owning one delivers unlimited local use and nationwide. Harnessing renewable energy sources shall be based on three important premises conferred by them, namely, accessibility, affordability and acceptability.

A solar panel or a solar panel mounted correctly (Fig. 1) can be reduced by up to 70% cost of heating a building. Solar heating to be seen not as a complete alternative to traditional heating system, but a system which ensures a reduction of heating costs, especially in the situation existing buildings, whose degree of thermal insulation is reduced. Solar panels are mounted on the roof in a south or southwest. The idea is that in that instead of the sun as much time in the day. It was not shaded by vegetation or buildings [9]. The panels are mounted at an angle of about 45 °. The panels weigh less (30-70 kg without water tank) and do not affect the structure of roofs that are installed. Weight reached a few tens of kilograms, depending on model. Then take into account the volume of water and if the external tank. Agent solar thermal plant can reach 120 °C [2]. Water temperature thermal battery can reach up to 90 °C. Hot water can be supplied at 75-85 °C, in summer, and at 15-45 °C during winter. Good still limited domestic hot water temperature at 55 °C, to avoid the deposition of limestone and also for security reasons in use. Limitation is made through controller [8].

1: Installation of solar panels.

Romania has a much more solar energy than other developed countries (Germany, Austria, Belgium, Netherlands, etc.), making use of any solar panel for producing electricity in places where there is access to national grid energy, become very interesting. when taking into account the costs of installation and that the electricity produced is free, their use in various applications, from solar panels are the best option. Solar plant consumption economy ensures a vacation residence. The advantage of this configuration is that power can be

extended up to 250 W 500 W 12 V or 24 V only by buying additional solar modules. Solar sensor consists of 2 pieces of monocrystalline solar modules of 90 W each. These modules are connected by a load regulator to a group of 2 batteries of 100 Ah each. From here you can connect devices that are designed to work with 12 V or 24 V. The group of batteries is connected to a 1200 W inverter that converts direct current from battery to AC 230 V, 50 Hz. Thus, the system can connect these devices: lighting with 4-5 energy saving light bulbs, fan, satellite, television, radio or computer. For safety and comfort can buy a wind generator of 400 W. In the case of Cloudy sky several days, a 400 W generator gasoline consumption of 0.4 litters per hour can be the ideal solution. Photovoltaic panels are guaranteed that they will work at least 80% of power for 25 years.

2 Types of Photovoltaic Panels

Photovoltaic panels are of several types.

IS10L photovoltaic modules, IS20L and IS40L consisting of 36 high efficiency monocrystalline solar cells covered with a glass polarizer. Special composition (solar cells encapsulated between two layers, one of plexiglass and a silicon that provide full insulation from water and humidity) and relatively small size of these layers (1 cm thickness) makes them easier to carry, maintain and installed. Each module is equipped with a waterproof junction box containing two connecting terminals for easy connection. IS10-20-40L modules are designed for small applications such as lighting lamps 12V DC, to power the security signals to load batteries and camping and many other applications. IS60 photovoltaic modules, IS75P, IS90 are systems generating electricity using mono or polycrystalline cells under the influence of sunlight to generate electricity. Photovoltaic panels is tied in series or parallel, generating a DC voltage of 12 V, 24 V or 48 V, DC Why are stocked with a load regulator in the battery or group of batteries connected in series and parallel as the system is designed. Energy is consumed in batteries or directly as current or an alternative cutent inverter turns to 230 V/50 H, is then used for household consumption or given/sold to the national grid. The modules are actually built the solar cells laminated between sheets of ethylene vinilacetat (EVA), ultra-transparent, anti covered with specially treated glass 4 mm (module protects against climatic and mechanical effects such as hail, ice, etc.).

Photovoltaic panels IS 120, IS 130, IS 140, IS 150 is composed of 72 polycrystalline and monocrystalline solar cells, high efficiency, the 125x125 mm, covered with a glass polarizer. Are systems generating electricity using mono or polycrystalline cells . Photovoltaic panels is tied in series or parallel, generating a continuous tension that are stocked with a load regulator in batteries or battery groups. Electricity is consumed in batteries or directly as current or by an inverter that converts into a cutent alternative 230 V/50 H, is then used in household consumption or supplied /sold to the national grid. Modules are actually built in solar cells vinilacetat rolled between sheets of ethylene (EVA), ultra-transparent, anti covered with specially treated glass 4 mm (module protects against climatic and mechanical effects such as hail, ice, etc.). The back, made of a white plastic, provide additional protection against electrical contacts module and shares climatic agents like humidity [5].

ISP 180 photovoltaic module is composed of 90 photovoltaic panels 2 W (72 consisting of polycrystalline and monocrystalline solar cells, high efficiency, the 125x125 mm, covered with a glass polarizer). To better meet the demands of the beneficiary, the module can be used in two versions: 12 V or 24 V. The module is equipped with a waterproof junction box, specially designed, enabling the voltage change at will. Thanks to recent technology Ultratron, ISP-series modules have higher performance achieving a higher power. This technology provides very good performance of the panels, producing energy even in terms of brightness smaller regions.

Such install, common network can be of three kinds (you may use and independent networks, i.e. with batteries to store energy at night): facility that is not integrated (i.e. the earth), semi-installation Integrated (on the roof, the facades, terraces, etc.) and integrated facility (embedded in the roof or facade). All have a special rate, starting 1-3 kW [none integrate (€ 0.40 kWh) semi integrate (€ 0.44 kWh) and integrated (€ 0.49 kWh) for 1 kW which covers an area of $8m^2$).

Projects are needed and qualified personnel to mount an installation in a building. There are two ways to exploiter:

- Change the station - if the current occurs all day and not eat little, so that you are at work or you do not need, then everything goes into the network, and when he came home tonight and eat in the network, shall be compensated, if it occurs more than they consume, you are entitled to use surplus next year;

Or transmission network - you can currently produce only to sell (not allowed to eat it for you), and the money comes from state and the power manager.

A 200 kW installation costs about €1,116,000, covering a space of 1700 m^2, when used as panels are guaranteed 25 years.

3 Using Fhotovoltaic Panels

Climate change and depletion of fossil fuels require substantial development of regenerative energies. Even sceptics have to admit that the earth is currently in a changing climate. Using solar energy provide the simplest way to stop this evolution. In the last 10 years heating and domestic hot water preparation with solar energy is an option to produce heat common in European Union countries. In cold areas in Austria, Denmark, Norway, Sweden, Finland, etc. solar collectors are widely used [3]. They are cost effective and winter sun to be! How Romania benefits annually for several days in the sun makes its appearance, it seems anachronistic to fail to take into account the largest supplier of natural energy. Sun's energy reserves are inexhaustible, the sun can not make taxes, and there rises prices [1]. Solar installations are used for obtaining domestic hot water, under floor heating and contribution to heat water in the pool. A solar plant (Fig. 4) is composed of [11]:

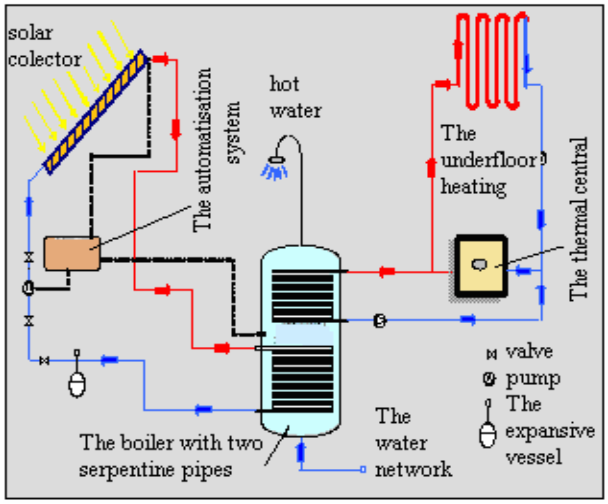
- solar collector (usually located on the roof of the house face south with an inclination of about 45 ^{0}) - Solar energy sensor;
- boiler bivalent (2 coils) (usually located near a central heating) - stocatorul hot water;
- which makes pipe closed circuit between solar collector and lower coil boioerului bivalent, thus circulating the heat pipe - glycol (like antifreeze) which has the property to maintain the characteristics of a large range of temperatures (-50 ^{0}C to 200 ^{0}C).
- circulation pump that put in motion glycol;
- automated circulation pump that acts according to the temperature recorded by sensors placed in the boiler, the collector and return pipes of the circuit.

Latest generation of solar collectors used as part insulating vacuum. If solar collectors panel Heliostar (Fig. 5) vacuum is 10^{-3} bar and if Mazdon tubes (Fig. 6) vacuum is 10^{-8} bar. Both types of collectors used to heat glycol. This type of agent makes possible the use of solar thermal collectors and winter (solar panels to heat water should be emptied directly when winter comes). The two variants differ by the capacity of solar collectors solar annual reported to 1m^2 (feature that gives the quality of a solar collector), respectively:

- panel heliostar: 638 kWh/m^2/year – values, for Germany and 1300-1800 kWh/m^2/year - values for southern Romania;
- tube mazdon: 784 kWh/m^2 /year
- values Germany or 1500 - 2000 kWh/m^2/year
- values for southern Romania.

In solar thermal agent (glycol) is heated to maximum temperatures of 130 to 200 ^{0}C and then down through a well-insulated copper pipes in the lower coil of a bivalent boiler (boiler with 2 coils - coil superior can connect a central heating).

Cold water introduced into the boiler will be heated by circulating glycol coil hot. In winter, the plant can not reach the desired temperature solar shower (about 42-43 ^{0}C) temperature difference will be made by the central heating system the upper coils.



4: Solar heating system for hot water preparation ménage.

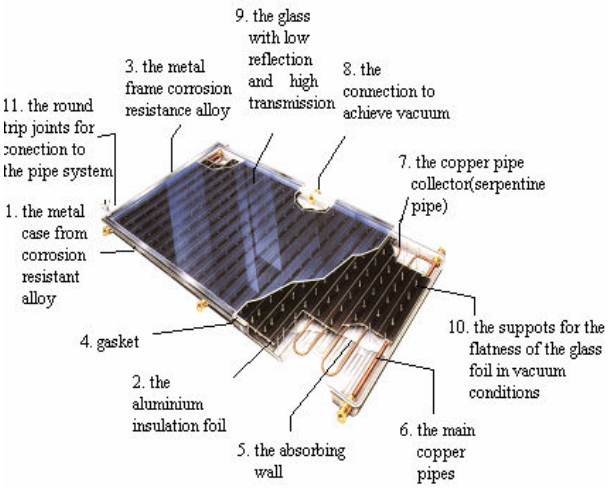


Fig. 5: Panel heliostar vacuum.

Sizing solar installation for hot water production is based on the number of people using hot water in a maximum time of day.

4 The Determination of Transfer Functions of Positioning Systems, a Photovoltaic Panel

Photovoltaic panels with an output of 3-81 W (12V output voltage) is a practical solution for small power consumers find in remote areas where electricity network is not available. Examples of applications: caravan, camping, remote cabins, electric power sensor environmental monitoring (weather stations, etc.) Six positions are scheduled daily at six different values corresponding to the

size of the prescription. It is assumed that the six positions are equidistant and that the path described by the sun is a semicircle (Fig. 2), deducting the six values of the size of the prescription: θ_c=0, π/5, 2π/5, 3π/5, 4π/5, π.

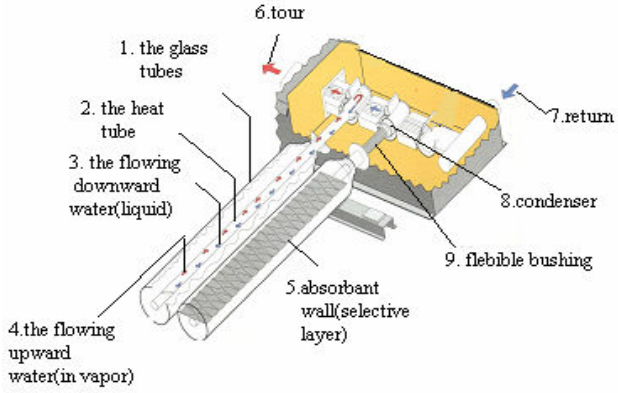


Fig. 6: Mazdon vacuum tube.

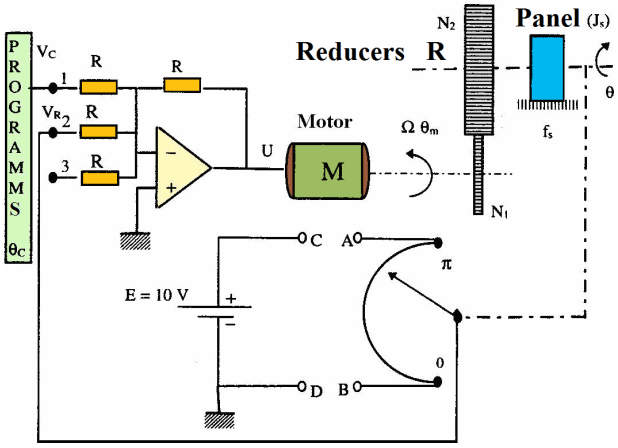


Fig.2: Scheme of control system in the angular position of the photovoltaic panel.

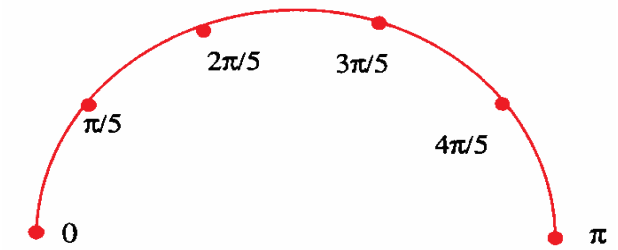


Fig. 3: Explanation on the choice of positions for the size of the prescription.

The device delivers a voltage considered prescribing V_c ranging from -10 to 0 V. The six values are obtained by prescribing the rule of three: V_c = (0, -2, -4, -6, -8, -- 10 V).

The engine *I* used is current, with separate excitation, with transfer function:

$$\frac{\Omega(s)}{U(s)} = \frac{1}{1+T_m s}, \qquad (1)$$

where: Ω is the angular velocity measured engine shaft, *U* is voltage control, T_m mechanical time constant is given by

$$T_m = J/f \qquad (2)$$

with *J* the total moment of inertia measured at the engine shaft and *f* coefficient of friction. Solar Panel of inertia *J* is trained to output gearbox reduction ratio *R* which is n=10 and J_s=100 kgm^2. Considering the reduction ratio *n,* the relationship between angular position panel and the engine θ_m is

$$\theta = \theta_m / n. \qquad (3)$$

Recognizing that the gearbox behaves as an ideal transformer, transcription forces equal upstream and downstream of the reducer allows demonstration that the motor shaft inertia is divided by the square of the reduction ratio $J=J/n^2$.

If all the motion being put on the panel is equal to f_s =1 corresponds to be calculated:

$$T_m = J/f = J_s/f_s = 100. \qquad (4)$$

Sensor consists of a rotary potentiometer; good walking is equal to 180°. Bring to an operational amplifier output voltage *U* of the same sign as θ_c, and thus the size at this point is negative. How operational amplifier introduces a minus sign, the voltage V_R must be in phase with θ corresponding to positions (AC and BD). V_R is null is also null and the contrary is maximum (=π), V_R is also maximum (=*E)*. It says the relationship between the sensor output voltage V_R and the position solar panel V_R=10/π. Buyer is made of an operational amplifier. Mounting operational amplifier used is a reverse floor adder, the exit is given by

$$U = -(V_C + V_R). \qquad (5)$$

Calculate the curl system damping coefficient ζ, the natural pulsation ω_0 and overcoming *D.* Transfer function of control system in the panel, using *Black's* formula is:

$$\frac{\theta}{\theta_c} = \frac{1}{100\pi s^2 + \pi s + 1}, \qquad (6)$$

same transfer function of a system II with increased static order 1, the natural pulsation $\omega_0 = \sqrt{1/100\pi} = 0.0564$ and the damping coefficient $\zeta = \sqrt{\pi/20} = 0.089$ (this value leads to a significant excess $D = 100e^{\frac{-\zeta\pi}{\sqrt{1-\zeta^2}}} = 76\%$).

Tachometric reaction. It is frequently used in practice. To improve system performance, the engine is mounted on a shaft tachometric dynamo that delivers a voltage proportional to velocity Ω: $V_d = k\Omega$. The plane model is to help tachometric reaction equation

$$V_d=k\Omega, \quad (7)$$

and the voltage change U as

$$U=-(V_C+V_R-V_d). \quad (8)$$

Calculate k to have an overrun of 20%,

$$\frac{\theta}{\theta_c}=\frac{1}{100\pi s^2+\pi(1+k)s+1}, \quad (9)$$

he value leading to a damping coefficient equal to 0.5 and thus $k=4.64$. The expressions of transfer functions, it is notable that in both cases the natural pulsation is the same. Instead of damping coefficient value can be adjusted separately for tachometric reaction. It certainly improves the adjustment. Installing such a system is simple and can be made by any beneficiary or installed with minimal knowledge of electricity.

If the panel is installed correctly, there's no maintenance required. If you only construction panel that runs through the summer, you must remove water from it before the first frost. It indicated, however once a year to grease the top tube heat exchangers with a special paste for maintenance. When are clouds or rain, sunlight capture tubes through the veil of clouds, but with a much lower efficiency. These days water is heated by electrical resistance using current solar panel or inside the boiler. Resistance was between 2 and 4 kW does not involve a large power consumption.

5 The Optimal Control of Climate Variables in Rooms Equipped with Photovoltaic Panels

Optimal adjustment of climate variables is performed, usually using a computer system or microprocessor-numerical-control system with heating and lighting of the premises (shutter position, so surface shading of windows). Apply in limited circumstances, i.e., rooms that can manage abstractions passive solar, natural ventilation, heating and lighting *(smart* room), so there is both comfort conditions and good natural lighting, throughout the year, with low energy consumption [6].

Optimized model, the corresponding structure adjustment climate variables is given in general by a system of discrete equations of order n form

$$\theta_i(kT_e)=\frac{B}{A}Q_i(kT_e)+\frac{C}{A}Q_S(kT_e))+ + \frac{D}{A}\theta_e(kT_e)+\frac{E}{A}w(kT_e), \quad (10)$$

where: kT_e) is the internal temperature at the time of discrete time kT_e (with sampling period T_e), expressed in ^{0}C, $Q_i(kT_e)$ is the amount of heat (derived from traditional heating system), or cold in the room, $Q_S(kT_e)$ is the solar energy transferred into the room through windows; $\theta_e(kT_e)$ is the outside temperature, $w(kT_e)$ is the disturbance process (due to errors occurring in operation), *A, B, C* are polynomials in the transformed z

$$A=1+a_1z^{-1}+a_2z^{-2}+...,B=b_0+b_1z^{-1}+b_2z^{-2}+...,C=c_0...\text{etc},$$

depending on the delay operator z^{-1} (over a certain size x) $z^{-1}x(kT_e)=x[(k-1)T_e]$. For find the correct values of the coefficients of polynomials that occur in the equation is used a recurrent estimator for the latest weather data. Optimized model, adaptive systems auto tuning appropriate structure shown in Fig. made in the form of equations of state [7]:

$$\dot{x}=Ax+Bu+Ew, \quad y=Cx+Du, \quad (11)$$

where: x size (2x1), is the vector of state variables, including measured values of temperatures θ_i and θ_z the temperature of the inner surface of the wall rooms), u size (2x1), the vector control (adjusts the amount of heat and shutter position for shading rooms); w size (2x1), is the vector disturbance (weather data - time), *y-size* (1x1), is the vector of output quantities (the internal temperature in the room θ_i). Identification method used to determine the *coefficient* matrix A(2x2) matrix of order B(2x2) transition matrix C(2x1), and output matrix D(2x1), is described by *Bacot* [4]

Adjusting structure using a mathematical optimization algorithm, which seeks to control variables in the set [*t, t+N*], with N horizon search, minimizing a criterion of the form

$$J\int\left[\frac{1}{2}(x(t)-x_d)M(x(t)-x_d)^T+C^Tu(t)\right]\text{dt}, \quad (12)$$

where: x_d is the vector desired temperature in the room at a time, and M is the matrix of cost (energy consumption), symmetric and defined semi positive, size 2x2. The algorithm requires knowledge of the future evolution of energy *M,* the desired internal temperature included in vector $x_{d,}$ and the state *x.* Future states are predicted using the model prediction for (weather forecasts). Knowing the vector of initial conditions $x_{0,}$ the algorithm developed in [5], calculated optimal control strategy leading to $\underbrace{\min}_{u\in U} J(x_0; t_0, u(t))$, subject to restrictions (the minimum amount of heat provided by the traditional system of room heating, and maximum solar energy capture).

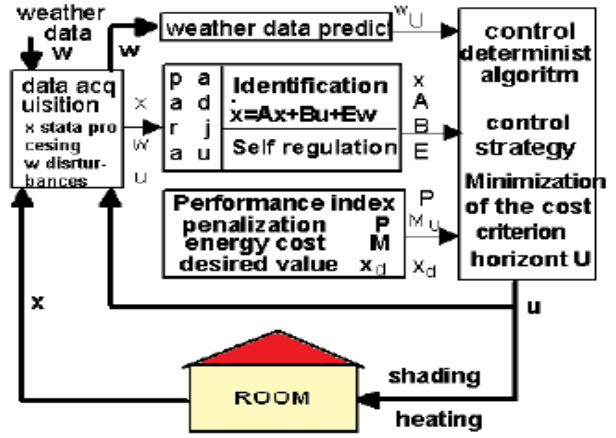


Fig. 8: Schematic block structure used to regulate climate variables with regulators.

6 Conclusions

We point at which electricity consumption by itself without huge costs and simultaneously reduce local budgets of all city halls in Romania. Solution at the moment is writing projects for photovoltaic energy, as long as you still have some funds halls consultancy. LPAs can access funds for energy costs 2% of the project. Support, design and offer specialized consulting in this area. Farmers with installations in the area that are large consumers of energy may also access the funds to reduce costs and create an integrated system based on energy produced by photovoltaic cells. Romania is located in zone B is sunny. The conclusion is that fully deserves an investment in a solar panel and in this regard.

Since completion of the work to the following conclusions:

A solar panel for heating domestic hot water tank heats up, daily, an average amount equivalent to the tank capacity at a temperature of 60-65 °C. In winter, because the day is much shorter?, water temperature reaches between 15-45 °C. Summer, sunny days, temperatures can reach over 90 °C.

Any plumber should know his law-cold water to hot water pipes in the house proper installation of solar panels in case of external tank. If solar panels and water heater inside the heat input is recommended to call the installers who have installed solar panels. The panels are constructed in a way, that the outside temperature does not affect the operation of solar installation. You must know but the winter period is less absorption of solar radiation for that day lasts fewer hours. But, we can compute a system - by increasing the surface absorption capacity, bring to a temperature of water heated by solar panel system 50-65 °C and winter.

In winter facilities must be equipped with dual cooling circuit, the circuit outside playing the role of anti-frost solutions. There are solar panels for the building to work only during summer, the vacuum tube for March to October.

If solar panels used exclusively for hot water to an estimated 5 years at most, usually 3-4 years, is decent. If panels used as the heat contribution depends largely on the insulation of the building where the solar heating system that works. Profitability is a solar panel on its long life: over 20 years with minimal maintenance costs.

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