Living in "Smart Cities and Green World"

Dr. Miranda HARIZAJ,
Polytechnic University of Tirana, Albania
E-mail address: miranda.harizaj@fie.edu.al / miranda.harizaj@gmail.com

Msc. Arjela NDREU,
Polytechnic University of Tirana, Albania
E-mail address: arjela.ndreu@fie.edu.al

Abstract
Every day we face fast development and technology appliance in each field of industry and our everyday life, with the focus of maximization of its service to people. Therefore, a special importance has been particularly given to the construction of "smart cities". This paper will support the idea of creating and usage a network that connects all the key points of human activities as the basis of a "smart" city, focusing on renewable energy, specifically solar one, to carry out these activities that a person performs throughout a full day. We are based on two features, "smart" and "green", which will include the electricity supply of the apartment and coverage of any of its indoor activities, street lighting, charging of electric cars and education on reducing pollution levels on nature.First of all, we will focus on presenting all the elements of this network, whose basis are photovoltaic modules, then we will introduce the creation of photovoltaic plants based on respective standards for their resistance to wind, with materials that do not pierce existing buildings and do not pollute the environment. Last but not least, based on the evaluation of collected results we recommend the effective ways of using photovoltaic systems in open spaces. We can mention lots of benefits by living in smart cities and green world, but most important would be the fact that we are going eco-friendly for the environment and creating economic development and jobs in ICT technology and other engineering fields. So, it's obvious as it implicates and affects the whole society and it is a productive and green way to smart the living in a safe and green world.

Keywords: renewable energy, photovoltaic modules, eco-friendly.

1. Introduction

Climate change and global warming are major concerns not only for environmentalists, governments and various organizations, but also for civil society. Because of reliance on fossil fuels over years, after considering their negative impact in environment, science is finding alternative solution to ensure change and protection to nature and humanity.

When taking into consideration the changes in technology of energy industry, they are obvious in the last decades. It has come a long way, since 1970s researching and investing in renewable energy as one of the best alternatives that ensures development and never-ending sources.While efficiency, maintenance or being nature friendly are the crucial requirements, gained electricity created from solar energy is evaluated as the best solution of nowdays.

This type of energy is eternal and the sun is considered a colossal source of energy. Energy is produced using solar cells, called photovoltaic cells, and converting it from direct current to alternating current with an inverter. Photovoltaics are undoubtedly turning into an affordable and low-carbon technological innovation, which is able to effectively utilize sustainable energy from the Sun. Solar energy means replacement of fossil fuels, green

technology, and implementation of this energy everywhere without any concerns for environmental damage.

Besides of all good qualities, our biggest interest would be green energy technology, that provides potential to cope easier and faster with each of smart cities or smart building concepts. This concept includes smart homes and as technology advances, our focus would be to expand the smart "trend" all over the city, to find the best ways of serving to each citizen.

1.1. Renewable Energy

The biggest consequences because of revolutionary developments in industrial fields that have driven the world for centuries towards fuels have undoubtedly been felt in human health, the global climate and in nature, as three-quarters of global greenhouse gas emissions come from the burning of energy fuels. Fuels are responsible for health problems that lead to at least 7 million premature deaths each year according to the World Health Organization (WHO) .

To reduce CO_2 emissions, local air pollution and all other consequences, there is a rapid shift towards renewable energy sources as it is considered as one of the factors that will play a key role in the decarbonization of our energy systems in the future. Renewable energy, which we refer to as clean energy and which comes from natural sources, is an innovative technology to utilize renewable sources.

Innovation and expansion of renewable energy sources is essential for maintaining a sustainable energy level and protecting the planet. Renewable energy sources make up 26% of the world's electricity today, but it is expected to reach 30% by 2024.

In the future, it is expected that the number of renewable energy sources will continue to grow as we see an increase in energy demand. This will lower the price of renewables. As today, the most popular renewable energy sources are:

- Solar energy
- Wind energy
- Hydro energy
- Tidal energy
- Geothermal energy
- Biomass energy

1.2. Solar Energy

Solar energy is a clean, cheap and renewable source of energy used everywhere in the world as every point where sunlight hits the earth's surface is a potential place to generate solar energy.Solar power systems can usually be classified according to their functions and operational requirements, component configurations and integration with electrical sources and charges. The two main classifications are network-connected interactive systems (on-grid) and standalone systems (off-grid).

There are various techniques to capture solar radiation and convert it into usable energy. These techniques use either active solar energy or passive solar energy:

- Active solar technologies use electrical or mechanical devices to actively convert solar energy into another form of energy, most commonly heat or electricity;
- Passive solar technologies do not use any external devices. Instead, they take advantage of the local climate to heat structures during the winter and reflect heat during the summer.

Electricity is an essential part of modern life and a very important aspect of our everyday activities. People find it difficult to adapt in a scenario where there is a lack of unlimited supply of electricity in their house.

Day starts and every person has his morning routine which includes a hot shower, a quick breakfast and probably a web surfing. Even though we only mentioned three different activities, for a successful fulfillment of this tasks we probably will count as minimum around ten devices/family that use electricity. Here we can mention sanitary water heater, water pump, toaster, freezer, coffe machine, juicer, charger, wireless modem and so on.

Every house has its basic needs of energy to meet all our vital needs, this being said, there is a total average energy consumption that is proportional to the different devices, equipment and households rated power expressed in kW (kilowatt). Each household equipment (take in consideration the efficiency and rated power) depending also by the work hours, gives us the grand total of energy consumption for that specific device. This way we can calculate the monthly energy consumption, and for each device we have a complete overview of the energy used to power our house. Let's see one example of a typical house consumption rate.

Table 1. Example of all elements that form the network of a house consumption, *Source: Authors*

No	Name Electric Household Appliances	No of devices	Power (kW)	Total power (kW)	Work hours in a day (h)	Total Daily Energy (kWh)	Monthly Energy (kWh)
1	Air Conditioner	1	4.5	4.5	3	13.5	337.5
2	Heater	1	1.8	1.8	2	3.6	54
3	TV	1	0.15	0.15	7	1.05	32.55
4	Oven 1	1	3	3	1	3	15
5	Oven 2	1	4.5	4.5	1	4.5	27
6	Fridge	1	0.123	0.123	6	0.738	22.878
7	TV2	1	0.07	0.07	2	0.14	4.34
8	Washing Machine	1	2.2	2.2	1	2.2	26.4
9	Pressure Cooker	1	1.6	1.6	2	3.2	64
	Lighting						
10	Main Lighting 1	3	3	0.053	2	0.106	3.286
11	Side Lighting 2	5	2	0.053	2	0.106	3.286
12	Spots	5	0.043	0.215	1	0.215	6.665
13	Spots	4	0.043	0.172	1.5	0.258	7.998
14	Hidden Lighting	7	0.0144	0.1008	4	0.4032	12.4992

As we can see the highest consume of energy in a typical house occasion is heating and ventilation, lighting, and kitchen cooking devices in some cases. This consumption is substantial for a normal continuity of civilized lifestyle and roughly 60-80 % of end customers can find themselves in this grand total of monthly energy consumption.The use of renewable energy sources in houses is evaluated as an efficient measure for saving the energy.

The most used renewable source in our homes is solar energy. Using a solar panel with surface 3-4 m^2 installed on the terrace / roof of the building for heating sanitary water saves the energy used for this purpose more than 60% of it. This percentage depends on the climatic conditions of the country. The greater the number of sunny days and the higher the solar radiation the higher the percentage of water heated by the panel.

In the same way we can speak of photovoltaic technology not only for heating water or warming inside our house through radiators but for capturing sun's energy and using it to power each and every one of our household devices.Photovoltaic technology is the tool that realizes the conversion of solar energy into electricity. This can be achieved without the use of fuel, which automatically reduces pollution levels but also increases savings in the economy as it requires maintenance to minimum levels. Today, photovoltaics is probably the most popular way to produce solar energy. Photovoltaic arrays usually include solar panels, of tens or even hundreds of solar cells.

The main identified problem of this power supply alternative is the inability to adapt production to demand, making this resource dependent on another method of supply or investment in storage modes such as batteries which add to the cost of investment and maintenance. In case of Albania, its geographical positioning makes this technology very useful to practice, but above all with long-term use.

2. Dimensioning our Photovoltaic System

When we face dimensioning of photovoltaic system based on our specific needs, there is some aspects that we need to consider which are divided in two main sectors:

- Legal Sector: Where we need to know our local regulations regarding small sized photovoltaic systems.
- Technical Sector: Where we need to have the total energy overview of house or building so we can properly dimension our photovoltaic system.

As per technical sector, as we previously mentioned we need the total energetic situation of the subject that is implementing the photovoltaic system.
We have calcultated the total energetic data related to a typical house case study in Tirana, we presented above, as in table below :

Table 2. Total energetic situation in the object, *Source: Authors*

Total Monthly Energy	617.4022	kWh
Total Monthly Energy For 2020	4510.00	kWh
Average Monthly Energy	375.83	kWh
Average Day Energy	12.12	kWh

We are considering that not each month of the year has the same rate of energy consumption, since this is dependent by the time of the year we are making this energy evaluation, as in several months heating or ventilation is not included since there is no need for. We calculate the grand total of 4510 kWh/annual, which in terms of per day consumption is around 12 kWh.

Table 3. Annual radiation and Installed power needed, *Source: Authors*

Annual Radiation	1854.69	[kWh/m2]
Specific Annual Output	1,253.60	(kWh/kWp)
Installed PV Power Needed	3.33	(kWp)

Here we can estimate the annual radiation of selected location. Typically in Albania, the annual PV output values are 1,000-1,400kWh/kWp. Our annual radiation is 1854.69kWh/m2 and our specific output is 1,253.60 kWh/kWp. This divided by our average monthly energy consumption gives us the needed installed PV Power so we can 100% cover our annual energy needs also by reducing our monthly energy bill.

There are a number of other coefficients that lead to a decrease in energy balance:

- Deviation from the standard spectrum
- Terrain Reflection
- Orientation and slope of the module surface
- Shading in each module
- Reflection on the surface of the module
- Global radiation in the module
- Global Radiation PV
- Pollution
- STC Conversion (Nominal Efficiency of the SunPower Solar Module based on manufacturer's datasheet is 19.88%)
- Partial shading in the module
- Deviation from the nominal temperature of the module diodes

Global Radiation per Year for this specific case (according to Photovoltaic Geographical Information System PVGIS) is 4,511.91 kWh/Year. Global radiation for our configuration case may differ since there is a number of events that affect it, from the types of modules, implementation and physical orientation of PV Modules from the sun.

In the below table present the results after the calculations of the installed power needed for our system, depending in the maximal power of the selected photovoltaic module.

Table 4. Calculation and characteristics of our system, *Source: Authors*

Pv Plant Selection	Self Sufficient System
Photovoltaic panels	SunPower P3 410Wp
Quantity	8
Peak power	3.28
Angle	30 degrees south without shading
Phases number	1 Phase on-grid

As shown above the number of modules needed for this house would be eight, with a peak power 410Wp.

We have selected for our case the photovoltaic system, presented in the Fig.1 below that matches our needs and is optimized for maximum performance and capable of maximizing the energy yield.

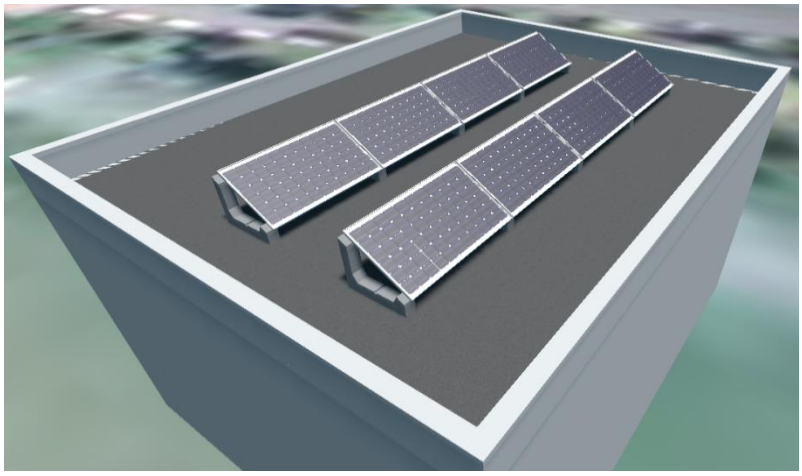

Fig 1. Simulation with INSUN of our photovoltaic plant
Source: Authors

So far we took care for the energy estimation aspect of installing a photovoltaic system. But since this system is composed of physical parts that need to stay in open air (typically in the roof of the building) to maximize the energy yield, we should calculate and ensure the system does not fall off in different weather scenarios but in the meantime ensuring that the building integrity and stability is not compromised.

3. "SUN BALLAST" Implementation Case Study

When we mentioned green energy, we talked about the ways of producing it. As known solar energy basis are photovoltaics, but we are going to study the way of going 100% green including installation for flat roofs with ballasts, specifically products that provide for installers calculation of wind resistance and weight/m^2. The sample to be tested consists in a constructive structure called "SUN BALLAST". It is made by two concrete blocks

which are shaped in order to support and to ballast photovoltaic panels and implemented in different places all over the world.

In Albania are different photovoltaic plants with different systems from "SUN BALLAST".The case we have studied is a photovoltaic plant in Tirana in an apartment, a few km from the centre of Tirana. The SUN BALLAST elements are realized according several geometries in order to get different exposition angles for the photovoltaic panels. The test report attains to tests completed for the types: 0°, 3°, 5, 8°, 10°, 11°, 15°, 20°, 30°, 35°, but the ballasts chosen for this case study are the standard ones 30° because they ensure maximum reliability, safety and efficiency, as well as a low environmental impact.

They are made with renewable materials and are the best way of building a solar plant in any roof without having to make any holes in it. As we mentioned the most important thing about this structure is that it is the only system that can modulate the weight according to needs and constraints structural coverage.

We are going to sum up the calculation of the example mentioned before, for an average apartment, in Tirana, Albania. First of all we have define the wind speed based on the division of Albania territory in two zones on the wind map according to technical designs conditions.

Fig 2. The map of divisions of Albania territory
Source: SUNBALLAST

In this photo is presented the map of Albania divided in two zones based on the wind speed. According to the map, the maximal wind speeds of the two zones are V_{b0}=25 m/s (the darker part) with a maximal wind pressure 40 kg/m^2 and V_{b0}=31 m/s with a maximal wind pressure 60kg/m^2 (the light part).

Secondly, based on the value of the wind speed we make the calculations according to "SUN BALLAST" coefficients and rules of calculations. This includes coefficient of

altitude, reference speed, return period of reference, coefficient of return, speed of reference of project, coefficient of topography x flat areas, coefficient of exposure, air density, kinetic pressure of reference are values defined by the distributor of ballasts, after some tests that they have made.Also the category of the ground has three coefficients for each one of the categories.We are going to choose suburban area, with an average height of 6 meters as the real case of implementation.
The coefficient of pressure is one of the most important coefficients in this calculation. It depends on the specific zone of the building that the photovoltaic modules are put. Since the modules are put in a distance from the corner this coefficient can be considered in the value Cp=0.9.

With the value of kinetic pressure q_p=57.58 Kg/m², Sunballast gives us the option of calculating the number of accessories that our system needs to be verified for not reversing because of wind pressure.

By putting the size of panel, and the weight of al accessories used, it's built the count table. In this case, even though the total number of photovoltaic modules is 8, the study for resistance of the wind is for each of the lines. In one line we have only 4 modules. As we mentioned before for one module are used two ballasts in both sides, for 4 modules are used 5 ballasts.
The overturning test is given as a comparison between stabilizing moment in total and averturning moment in total. From the calculations that are made, the overturning moment has a lower value that means that the system of ballasts is stronger than the wind speed and the line of photovoltaic modules is stable.

3.1 Advantages

The study cases of solar plants with SUNBALLAST system has advantages as below:
- High wind resistance
- Wide range of inclinations (from 0 ° to 35 °)
- Low loads in coverage
- Flexibility
- Ability to circumvent any obstacle in coverage
- As for smart home,the benefits of this home automation we can mention:
- Remote Acess for distance control of household devices
- Comfort and convenience, since users have the ability to preprogram devices like thermostat for heat control, dimmer for lightning control based on time of the day and so on.
- Increased safety by including fire alarm systems and detectors, pressure sensors and different other devices that can help users protect their house from disasters.
- Energy efficiency for saving electricity usage by reducing the length of time lights stay on, air purifier, HVAC dynamic control when users leave the room and so on.

4. Smart Living by Home Automation

The meaning of home automation is to build an "interior network" of all electronic devices which are connected through communication protocols, that provides automatic control. All these devices will have an ethernet or LAN connection, so they can be managed remotely. For that we can use an app or voice assistants.Three are the main points considered to provide home automation:

- monitoring
- control
- automation

To have a better sustainability, not only is important to auto-generate efficiently the electricity, but also to use it in a smart way. Besides the automation process, we should take care and improve the control and monitor of identified electric devices and households that have the highest energy consume:

- Air conditioner or HVAC system uses the most energy of any single appliance or system which is roughly around 46 percent of total energy consume.
- Different home appliances like oven, pressure cooker, air purifier, account for about 13 percent of the typical energy consume.
- Television and Media Equipment make up about 4 percent of our energy use.
- Lighting accounts for about 9 percent of a house's energy use.

For a better understanding of above mentions, table below represents a typical case for an average house and specific power of each appliance.

Table 12. List of home appliances and their relevant power in (KW), Source: Authors

Description	Power (kw)
Air Conditioner	4.5
Calorifier	1.8
TV	0.15
Oven 1	3
Oven 2	4.5
Fridge	0.123
TV2	0.07
Washing machine	2.2
Pressure Cooker	1.6
Lighting	
Main Lighting 1	3
Side Lighting 2	2
Spots	0.043
Hidden Lighting	0.0144

The above table shows the main household devices that, if left unorganized untreated within an efficient centralized controlling system, can bump up the monthly energy consume. This organization consists in a way for user to lower energy consumption by efficiently using household devices and appliances and therefore household expenses only with a Home Automation System.

Efficient household appliances use less electricity compared to those used so far in our homes.For this reason it is recommended that in our apartments when the opportunity arises to use efficient household appliances. By today's standards, devices belonging to class A, A+, A++ are the most efficient devices. Class A, A+, A++ devices are the most efficient devices.

Recent studies show that stand-by electricity saving of household appliances is 5-10% of the annual electricity consumption in dwellings.
The concept of Home Automation aims to bring the control of operating your everyday home electrical appliances, thus giving user affordable lighting solutions, better energy conservation with optimum use of energy.

In addition to simple lighting solutions, the concept also extends further to have overall control over the safety of your home, as well as to build a centralized home entertainment system and much more. The Internet of Things home automation system or commonly referred to as IoT, as the name suggests, aims to control all of your smart home devices through Internet protocols or cloud-based computing.But how does this system work?

“Home automation” refers to the fully automatic and electronic control of household features, activity, and appliances. In simple terms, it means you can easily control the utilities and features of your home via the Internet to make life more convenient and secure, and even spend less on household bills. This allows you to turn on the lights, lock the front door, or even turn down the heat, no matter where you are by using only three main components / elements of a home automation system: sensors, controllers, and actuators.

4.1. Home automation tools

Controllers are used in home automation to send and receive information and commands. The primary controller is the most essential part of your home automation system, whether you connect single or multiple sensors. The main controller is also called a gateway and is connected to your home router via Ethernet cable. All IoT-based sensors transmit or receive commands through the centralized center. The hub in turn receives the input or communicates the output to the cloud network located on the Internet.

Due to this architecture, it is possible to communicate with the centralized center even from remote and remote locations via smartphone. All you need is a reliable internet connection at the hub location and data packet on your smartphone to help you connect to the cloud network. Most of the smart home controllers available from different manufacturers are tied to all three widely used protocols of wireless communication for Home Automation: ZigBee, Z-Wave and Wi-Fi.

Sensors are used in home automation to monitor the status of surrounding environment like movement, changes in daylight, temperature or so.

Automation Sensors are the eyes and ears of the smart system, informing the user and other smart devices of changes in status 24/7. Automation Sensors take control of your lights and appliances so you can customize how and when to control devices around your home. All this devices are connected over a common network established by gateway and connected in a mesh network to give to the user the flexibility to operate one sensor as a result of the status of the others.

Actuators can serve in home as electronic end-devices that can be light switches, motorized valves, or general device that is commanded from the main controller.
Automation actuators are like the end devices that take orders directly from the user or the controller by the status of different sensors. This can be scheduled to be done automatically or manually.

An energy efficient way of using actuators is by programming a dynamic behaviour of different appliances of the house like heating or lighting, to change their status as a result of users way of living.

5. Green solution of photovoltaic systems in public spaces

There are different ways that we use solar energy to further assist our smart and green living. We now know several effective way of using photovoltaic systems. The use of this technology can help us lower our dependency from local grid supplier, and by greatly increasing energy efficiency for a typical house, by solar inversion in order to autogenerate electricity and also to heat water or probably even house through radiators.

But how can this innovative technology that is so distributed in different energy aspects can affect in open and public spaces. We are considering several ways that are directly connected to peoples needs.

5.1 Solar Charging Station

With the increase of Electric Cars use in mass, there is a need that users find EV Chargers everywhere possible in order to continue a long trip with an electrical vehicle. This can be done efficiently by implementing a Photovoltaic parking with EV chargers included. This will not only maximise green energy policy by using electricity for transportation but even by generating this energy we need from solar. A solution like EV Charging in Photovoltaic Parking also increases independency from local grid supplier, by lowering technical losses of energy in long distance transmission of lots of MWatts of power to fulfill the EV Charger needs.

Fig.2 A photovoltaic parking with EV chargers included
Source: https://www.cnrockwill.com/new-energy-solutions/pv-energy-storage-system-in-ev-charging-station

5.2 Photovoltaic Tree – Charging Bench

This is another interesting use of solar energy in public in which its included an artificial solar-powered tree that evokes people's everyday habits such as sitting under the tree and using the nature as a shelter from the sun. This product gives the possibility to quickly charge the phone, tablet or laptop in the meantime.

Fig 3. Photovoltaic Tree that includes charging bench
Source: https://strawberrye.com/

5.3 Photovoltaic Lights

This solution of use in photovoltaics can help the general public by ensuring uninterrupted lighting system in every part of the city or town.

Fig 4. Examples of street lighting system and traffic light using photvoltaics
Source: https://www.mosallastraffic.com/product/products.htm
http://www.essofabtech.com/solar-street-light.php

6. Conclusions

The world keeps facing with two biggest problems with electrical energy, the lack access to sufficient energy entirely for millions of people and the link between energy access and greenhouse gas emissions.This is the reason why the solar enery is recomemended as the best solution for low carbon and cheap large scale energy.

Thanks to solar energy and infrastructure the future of the city aims to be more efficient, connected and sustainable. Aiming to make cities smarter and greener too, it's the best way to change the way municipalities operate and help citizens maximize their potential as responsible, sustainable members of a global community.

Implementing solar plants all over the city will drive toward cleaner air and reduced noise by deploying renewable distributed energy resources and clean mobility.

Last but not least, based on the evaluation of collected results we recommend the effective ways of using photovoltaic systems in open spaces. We can mention lots of benefits by living in smart cities and green world, but most important would be the fact that we are going eco-friendly for the environment and creating economic development and jobs in ICT technology and other engineering fields. So, it's obvious as it implicates and affects the whole society and it is a productive and green way to smart the living in a safe and green world.

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