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The Impact of Residential Optimally Designed Rooftop PV System on Libya Power Shortage Case

Saleh Eshtaiwi, Mustafa Aburwais, Osama Elsanusi, Mustafa Elayeb, Mohamed Shetwan

Summary **— The average yearly hours of sunshine in Libya reaches 3200 hours and solar irradiance rate approximately ranges from 6 to 7 kWh/m²/day. However, small solar parks projects are now undergoing and some are lately under cadastral and field survey. In meanwhile, $922.7M is the average annual government fund paid for electricity generation sector. It thus results in Tariff of 0.082 $/kWh. This paper studies the potential of hybrid rooftop PV solar systems to supply household appliances and then proposes a 5.65 kW$_p$ PV solar system appropriate for Libyan home's rooftop to mitigate the consequences of load shedding due to electric power shortage. Accordingly, oil uses in electricity generation will be gradually reduced as a result to rooftop PV systems widely spread. Finally, the overall benefits, simulation summery and implementation approach are provided.**

Keywords **— hybrid, load shedding, PV solar system, rooftop, utility grid.**

I. Introduction

The Libyan power plants rely only on conventional fuel such as heavy oil, light oil and natural gas. Those power plants are the main electricity supplier to the Libyan grid. The average efficiency of 6.4 GW generated power of aforementioned power plants is about 33% [1]. This much of energy requires about 3.5 million m3/year of heavy and light oil in addition to 6,531,492,999 m3/year of natural gas [1].

The fuel costs the government about $4.5 million per day [2]. As a result, the government is selling the electricity energy at a Tariff of 0.083 $/kWh. The government is funding and supporting the burned fuel by about 655-1,318 million dollars annually depends on oil and natural gas national prices [1], [2], [3].

Fig. 1 illustrates the amount of fuel that is consumed in the Libyan power plants in a period of 2013-2021 [4].

Throughout Libyan sectors, the residential sector has been found consuming the most see Fig. 2.

(Corresponding author: Saleh Eshtaiwi).

Saleh Eshtaiwi is with the General Electricity Company of Libya (GECOL), Tripoli, Libya (saleheshtaiwi@ ku.edu).

Mustafa Aburwais, Osama Elsanusi and Mustafa Elayeb are with the Misurata University, Misrata, Libya (mustafa.elayeb@eng.misuratau.edu.ly).

Mohamed Shetwan is with the College of Industrial Technology, Misrata, Libya.

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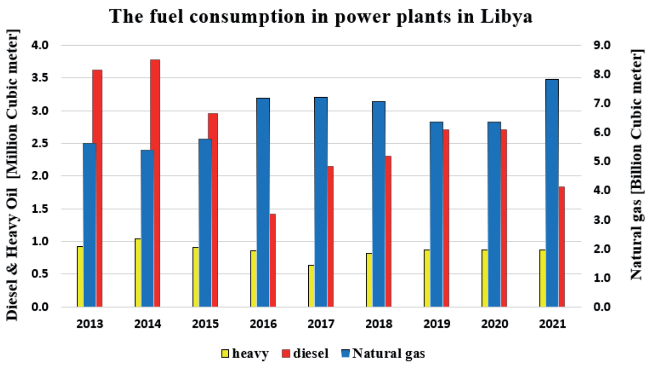

Fig. 1. The fuel consumption in power plants in Libya

At the residential sector, Population growth and high standard living achieved in the last decade could be the main reason of high percentage of electric energy consumption. The higher consumption of electric power increases the power demand to around 8 GW with an estimated shortage of 1.6 GW [4].

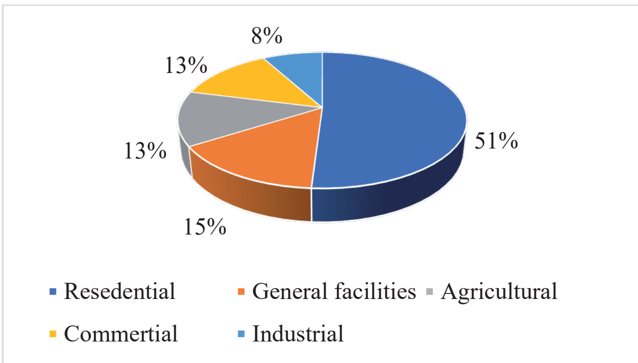

Fig. 2. The electricity energy consumptions of Libyan sectors

Formerly, the country vision was only limited to found new conventional power plants, which necessitates a great investment as well as long time is required, while no serious effort toward the available sustainable energy resources. However, Libya has elevated solar irradiance reaches 2300 kWh/m²/year and sunshine duration is near 3200 hr/year [5], compared to other world countries, who has smaller amount and have made a great trade in the field. For instance, China vision by 2030 is to exceed 26% of renewable energy sources [6]. Meanwhile the United States of America goal is to achieve 22% of their generated power from renewable energy resources [7], [8]. In Libya, the current instability in a political environment have posed a great challenge to the General Electricity Company of Libya (GECOL) who became unable to overcome the escalated growth in power demand. Therefore, GECOL is daily scheduled a load shedding during summer season as a precaution to prevent a complete blackout. Nowadays, the GECOL has lately started an investment in PV solar parks. It newly has signed agreements and contracts with some international companies, such as TotalEnergies and EG. TotalEnergies will start a project of 500 MW_p solar park in Sadada region (around 70km east of Misrata city) and a capacity of 200 MW_p with the EG company in city of Ghadames (300km south of Tripoli) [6].

In this study, rooftop PV system is carried out to get it installed in 100,000 houses all over Libya. The system is going to be simulated to supply the residential sector and come over the electricity shortages. A case study in the city of Misrata is simulated and analyzed. Misrata is the third largest city after the capital city of Tripoli and the second city of Benghazi. Misrata is located in northwestern of Libya, situated 157 km to the east of Tripoli and 825km west of Benghazi on Mediterranean coast. The latitude and longitude of the city are 32.4° and 15.1° respectively, and the elevation is 10m.

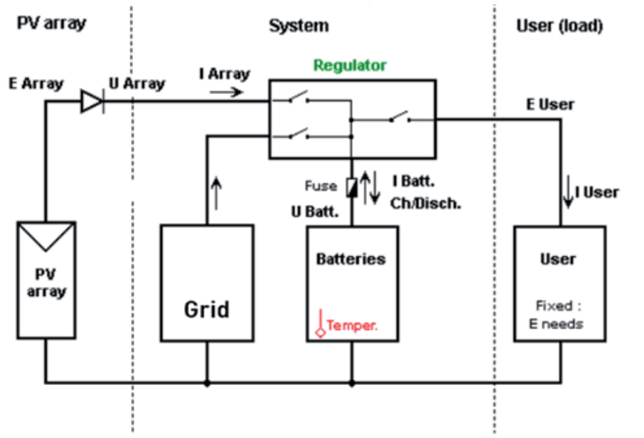

Fig. 3. Proposed PV solar system

II. Rooftop Solar Systems

The residential and general facilities loads exceeds 66% as shown in Fig. 2, which is the largest consumers compared to the other sectors as revealed in [7], [8]. The potential of installing PV systems on house's rooftop was also discussed. It is a promising approach to avoid an expected grid black out because of power shortfall in Libya. The solution suggests that the national grid is used along with solar panels to feed the household appliances through a hybrid inverter (no power injected into grid) [4]. This is an effective scenario since the implementation is going to be easy to install, and fast to get it run. It simply guarantees the continuity operating of all necessary household loads. Certainly, it will gradually strengthen the concept of grid independence, actively change Libyans' consumption behavior and encouraging saving the national resource. It will also localize a new environment-friendly technology in addition to limits dangerous spread of backup generators. Furthermore, in upcoming future, rooftop systems can hereafter sell the electric power to the public grid, whenever an appropriate legislation (regulations) and infrastructure become available.

A. Components of Photovoltaic Solar System

In Libya, the available PV panels today have a commercial dimension of approximately 2 m² to produce about 535W_p with a lifespan of at least 25 years. Trina Solar has lately revealed a capacity of 600W_p [9]. The panels produce a DC, and then an inverter is required to run the AC loads. While load shedding, the panels should be connected to a battery bank to meet the energy demand at night [10], [11], [12]. The process of batteries charging and discharging is usually carried out by means of a controller. In modern models, the intelligent controller is integrated into a hybrid inverter which can be programmed to set the priority of feeding the load whether from PV panels, grid, or batteries as shown in Fig. 3.

B. The Advantages of Rooftop Systems:

- The PV system is only designed to feed the house, so no government regulations are needed.
- No land allocation is required from the state of Libya since the installation is on house's rooftop.
- The project (proposal) costs the state of Libya nothing neither operationally nor security obligations since it is under owner's care and responsibility.
- The project can noticeably make a change on the owner's life routine since the installation and setup takes a few hours, and power supplying will start immediately.
- For installation, no highly proficient technicians from abroad are needed, and therefore systems can be installed by local technicians after receiving a simple training.
- While backup generators are only start running once load shedding scheduled, rooftop systems are designed to permanently supply power to household appliances and as number of installed systems increase, power shortage decreases.
- As much as installed systems rises, the outcome is founding an equivalent conventional power plant at no government fund.
- In a case of citizens' financial hardship, only part of the essential loads can be basically fed, and then rooftop system's size can be expanded later as individual's economic conditions might improve, or because of technology development, prices may essentially decrease.
- The spread of rooftop systems will absolutely trigger the labor market as well as improve local economic conditions since it will offer more job opportunities in terms of installation and maintenance.
- PV system is confidently not source of noise, air pollution, or natural resources depletion, it basically requires a little maintenance within 5-10 years.

The battery lifespan varies between 3-5 years depend on the DOD% while the lifespan of the inverters has exceeded 15 years [4],[13],[14]. The system's lifespan is more than enough for the GECOL to come up with a solution. One of effective solutions is approving new legislation that is feeding the grid through bidirectional meters [15]. In reality, new private companies have already launched to import and install PV systems besides offering ancillary services such as maintenance, developing technology, and equipment (modules and batteries) recycling [4].

III. Typical House Daily Consumption in Libya

Actual measurements were obtained from GECOL based on randomly selected Libyan houses and were recorded by using the *VIP System3- energy analyzer*. It measures the actual consumption of the traditional Libyan houses. Fig. 4 displays real household consumption within 24 hrs.

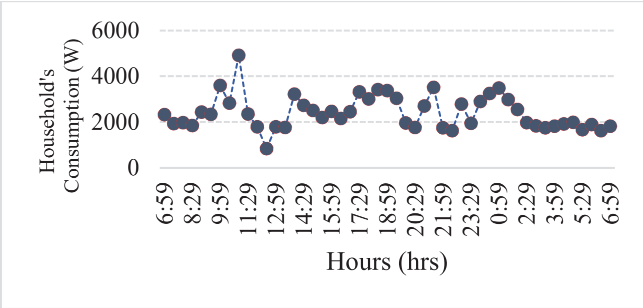

Fig. 4. Actual household consumption during 24 hours (daylight and night time)

From Fig. 4,5 and (TABLE I), it can be clearly noticed that the total consumed energy is completely unacceptable to get it supplied by using PV systems due to unconvincing cost, limited rooftop area and therefore our proposal is only restricted to the necessary household appliances as described in (TABLE III).

The real consumption can be summarized for the selected model (house), as shown in (TABLE I).

Table I

Actual Consumption of House on Libya

Total rated power of household loads (kW)	Maximum actual household consumption Power (kW)	Daytime household consumption (kWh)	Night household consumption (kWh)	Total (kWh)
11.598	4.918	25.6	30	55.6

IV. Sizing Rooftop System

The appropriate size of rooftop solar system should be chosen to supply the household loads which are available on the most of the Libyan traditional houses. The final selected size should be feasible technically and economically and as a result, three different scenarios were studied:

A. Scenario (I):

The PV solar system is sized to supply all household appliances and fulfill the customer needs. The home study model was measured by the *VIP system3*, in (TABLE I).

On (TABLE II) it can be obviously realized that the suggested PV system will have a large capacity, and high rate of battery discharge. It results in a high cost and probably becomes impossible to install due to limited roof area. Therefore, the model has been excluded at this stage.

Table II

Specification PV System of 1st Scenario

System Component	Total Capacity	Qty	Note
PV panels	535**W**	20	Well-matched system's component should be selected and appropriate to Libyan environment (temperature, dust, wind speed …etc)
Deep cycle batteries (DOD 60%)	**200**Ah, 12V	**12**	
Inverter	10 kW	1	

B. Scenario (II):

In this scenario a PV system will supply household basic loads and neither an air conditioner nor heating appliances were included. Their power consumption is too high; therefore, an inverter air conditioner and domestic water heating are really recommended [4]. The details of each PV system components are as shown in (TABLE III) [4].

Table III

Specification PV System Of 2nd Scenario

System Component	Total Capacity	Qty	Note
PV panels	535Wp	6	Well-matched system's component should be selected and appropriate to Libyan environment (temperature, dust, wind speed …etc)
Deep cycle batteries (DOD 75%)	200Ah, 12V	4	
Inverter	3 kW	1	

C. Scenario (III)

In scenario *(III)*, studying the effect of adding only one highly efficient inverter air conditioner with a capacity of 12kBtu/h (no more than 700W) is analyzed. The consumption will slightly increase compared to the 2nd scenario, and thus the components of the system also increase. They are verified in (TABLE VI), which requires an increase in the PV modules and battery's storage capacity. This scenario is providing all household utilities with enough energy. However; legislation by government is needed to prevent using traditional air-conditioners.

Table IV

Specification PV System of 3rd Scenario.

System Component	Total Capacity	Qty	Note
PV panels	565Wp	10	Well-matched system's component should be selected and appropriate to Libyan environment (temperature, dust, wind speed …etc)
Deep cycle batteries (DOD 75%)	200Ah, 12V	8	
Inverter	5kW	2	

D. The Proposed PV Rooftop System

Based on the above-mentioned three scenarios, the scenario (III) was preferred and selected. The PV hybrid system provides the required energy to Libyan household's appliances. The PV system size will be limited to supply loads shown in (TABLE V). It reduces the inconvenience in case of scheduled power cut off with the possibility of developing, the rooftop system later on to be on-grid.

Table V

The Expected Basic Load for 3rd Scenario

Appliances	*Rated kW*	*No*	*∑kW (max)*	Hours/day Used		*Energy/day kWh*	
				Daytime	*Night*	*Daytime*	*Night*
Fridge	0.25	1	0.25	6	2	1.5	0.5
Freeze	0.25	1	0.25	6	2	1.5	0.5
Lamps	0.025	30	0.75	1	3	0.75	2.25
Washing water pump iron	1.5	1	Programming (One per day) 1.5	2	-	3	-
TV/PC/ Electric intake	0.1	6	0.6	3	3	1.8	1.8
Air conditioner	0.7	1	0.25	8	-	5.6	-
Total			3.35			**14.5**	**5.05**

Proposal Hypotheses

- The government needs to fund 100% of system total cost, while the ownership is going to be transferred to the citizen within 5 years (which is enough for refund)
- The citizen is encouraged to afford the installation and maintenance fees.
- The citizen should change the traditional air conditioner to highly efficient inverter air conditioner.
- The citizen will be able to feed the grid once the regulations are approved to allow GECOL to buy the supplied energy.

In order to extend system life, it is recommended to literally take into account the following points:

1. Directing the consumers towards energy-saving and highly efficient appliances to apply the concept of energy efficiency. It is highly worth it if current household loads are replaced regularly by highly-efficient appliances.
2. Mainly, the daytime is the most appropriate time for consumption thus, the consumers should be aware to have most of their activity done at daytime.
3. Avoid excessive consumption, especially during the night time, due to side-effect on the battery's lifespan as long as the batteries represent the highest weight in the system's cost.
4. Only operate the recommended appliances and avoid heavily power consuming ones to extend batteries' life.

V. Case Study

In this paper, the significance of the proposed rooftop system will be studied in the city of Misrata, which is the third largest Libyan city. It is almost 210 km east of Tripoli and on the southern coast of the Mediterranean Sea. The curve shown in Fig. 5 illustrates the loads in Misrata which is daily fed from the GECOL's utility grid during the year of 2019, where it shows the maximum peak hitting 464 MW on September 9 of 2019.

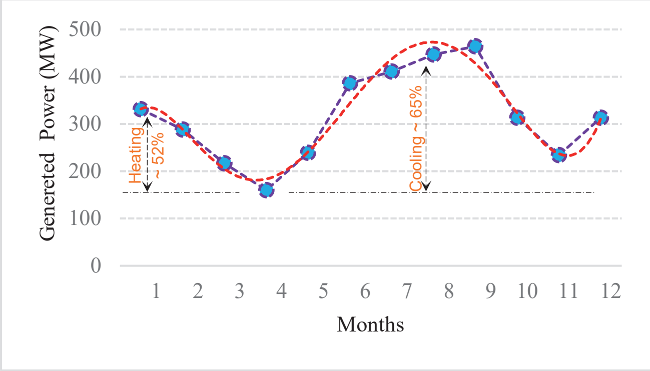

Fig. 5. The loads in the City of Misrata 2019

The simulation was carried out by PVsyst software for the proposed PV system on the Libyan case. In our scenario, it should be noted that the grid is going to compensate the energy needed of house utilities whenever a shortage happens of the system. The solar fraction in (TABLE 6) confirms that the obtained data can be used for economic calculations as well.

During the simulation, PVsyst software updates its meteorological data for the whole year based on the location of the proposed rooftop solar system. The data should include the horizontal global irradiance (GlobHor), horizontal diffuse irradiance (DiffHor), clearness index, ambient temperature, and wind speed. For city of Misrata, the latitude is (32.375°, 15.0915° longitude), GlobHor is 1755.3 kWh/m² /year, DiffHor is 831.3 kWh/m²/year, clearness index is 0.556, ambient temperature is 21° C, and wind speed is 4.3m/s.

From the PVsyst software simulation of the third *Scenario*, the total number of required batteries are 4 in order to meet the energy demand. The proposed battery is a 200 Ah with a nominal voltage of 12V for each. The battery has coulombic efficiency of 97%. Additionally, the batteries are expected to have the capability to supply the expected loads for one day. There are 10 PV modules to satisfy PV array configuration and used to electrify the loads besides charging the required batteries. The PV array is expected to generate nominal power around 5.65 kW_p. The proposal's design considers that the PV module output changes based on solar irradiance, ambient temperature and load demand.

In PVsyst software, the inverter and MPPT charge controllers are part of the regulator configurations. The nominal voltage is 48V. The selection is made based on system voltage on the battery storage. The controllers can regulate up to 5.65 kW of the maximum output power received from the batteries. From the simulation analysis results, the average unused energy is 1.1 kWh/kW_p/day, collection loss is 0.71 kWh/kW_p/day, system losses and battery charging are 0.56 kWh/kW_p/day, and energy supplied to the user is 2.85 kWh/kW_p/day.

In Fig. 5, the normalized energy production, which is distributed all over the year, is verified. The highest generated energy production is up to 6.2 kWh/kW_p/day and would happen from July and August. The main reason for high consumption is the traditional air conditioner as well as water heater. On the contrary, the lowest production will happen in winter from November to January with amount above 2 kWh/kW_p/day. As shown in Fig. 6, the most losses of PV modules occur in July, and August. Further, the highest unused energy plainly seen on May, June and July, respectively

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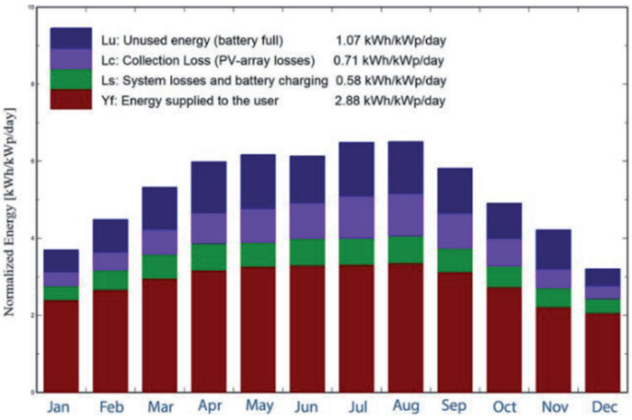

.Fig. 6. Monthly energy production with losses.

Fig. 7 reports the Performance Ratio (PR) within a year. PR is the system efficiency during the year and gives information about the impact of overall system losses on the rated output. The losses include PV module, tilt angle, dust, shade, as well as module temperature losses.

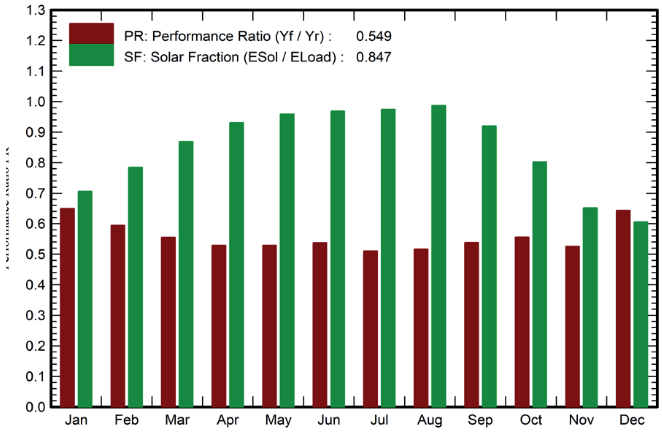

Fig. 7. Performance ratio and solar fraction using PVsyst.

Results using monocrystalline silicon PV modules indicate that throughout a year, the system exhibits a fluctuation, while solar fraction has experienced an increasing trend in the first four months of the year. Then, it has remained constant for two months and a rise in the next two months. Finally, a decreasing trend has occurred in the last four months of the year.

VI. Estimated Costs of the Proposed System

Based on the selected rooftop system the obtained energy from a 5.65 kW_p PV system is going to be very sufficient with slight back-up from grid to compensate any shortages to ensure smooth system operation. Therefore, the significant home appliances can be supplied via PV system described in (TABLE III), and its estimated cost is roughly $4,300.

VII. Financial Support for solar systems

The paper recommends that $430 million should be annually assigned to the total cost of 5.65 kW_p rooftop solar systems. It will effectively lead to installing a PV system in almost every Libyans household within 7 years. It may be useful to establish investment fund to support the proposal throughout additional public fund from other institutions such as, telecommunications companies, banking sector, and heavy power consumers from both public and private sectors. It is considered as financial compensation for their high consumption of subsidized electricity.

The installation of proposed project will visibly save the government support which is frequently paid to fund all kind of fuel used in traditional power plants, and it can be partially forwarded to yearly support such solar systems proposal.

VIII. The Proposal's Outline

The proposal initially aims to install 100,000 systems with a capacity of 5.65 kW_p within a year at a rate of 400 systems/day.

It further requires a training of 1056 people for installation progress. The cost of such systems is estimated to approximately $430 million. The Libyan government bears 100% of total cost. (TABLE VII) summaries the simulation and the study of the proposal.

Table VI

Energy Use

	EArray kWh	E_Load kWh	E_User kWh	E_BkUp kWh	SolFrac ratio	T_LOL Hour	Pr_LOL %
January	484.5	595.9	593.4	168.3	0.713	0	0.00
February	509.5	538.3	533.8	98.0	0.810	0	0.00
March	628.6	595.9	591.0	59.3	0.892	0	0.00
April	659.9	576.7	569.8	32.5	0.932	0	0.00
May	690.2	595.9	589.1	7.7	0.976	0	0.00
June	668.0	576.7	569.1	17.3	0.957	0	0.00
July	687.8	595.9	588.6	16.3	0.960	0	0.00
August	712.0	595.9	587.6	0.0	0.986	0	0.00
September	642.9	576.7	570.2	31.5	0.934	0	0.00
October	549.4	595.9	591.4	128.4	0.777	0	0.00
November	455.0	576.7	573.3	197.5	0.652	0	0.00
December	381.6	595.9	594.9	277.3	0.533	0	0.00
Year	7069.4	7016.8	6952.2	1034.0	0.843	0	0.00

IX. Expected Proposal Benefits

A. Libyans Citizen's benefit

Libyans who obtained such a PV system with an installed capacity of 5.56kW_p, are going to offer an annual electrical energy of 48.7MWh, which is sufficient to run all of the important appliances in typical Libyan houses, including highly efficient invertor air conditioner. The system is hybrid whenever there is no enough power at the PV system the grid will feed compensate the loss. Fig. 8 shows the annual back-up energy that is required from the grid compared to the solar power generation. It is clear that the first four months and last three months of the year there is back-up needed while slight to no back-up is needed for April, May, June, July and August. The annual back-up energy is estimated to be 1073 kWh

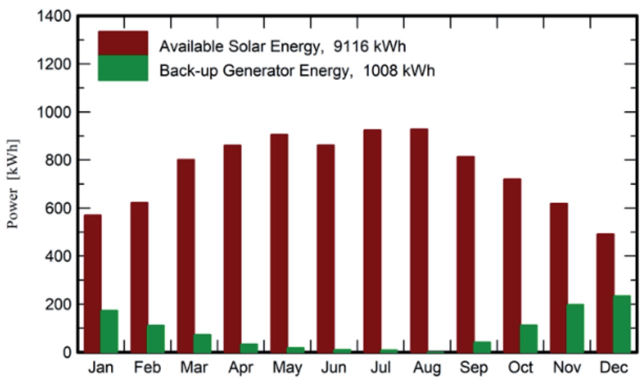

Fig. 8. The annual back-up energy required for one system compared to the solar power generated

The available annual solar energy of the system is estimated to be 9116 kWh while the annual energy need of the user is estimated to be 7,017 kWh as shown in Fig. 9. It is clear that there is no back-up needed. However; the collection loss, system losses and battery charging made the back-up compulsory (see Fig.6 and Fig. 10).

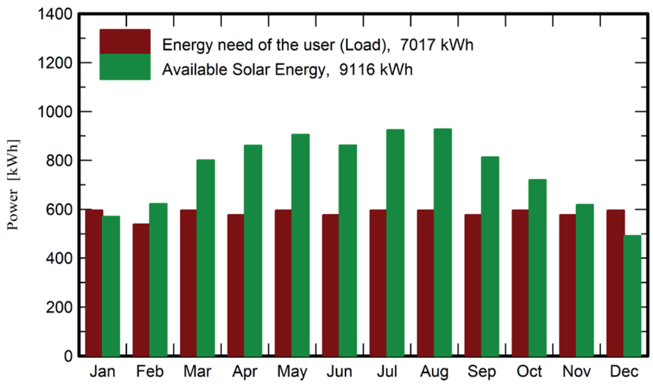

Fig. 9. The available solar energy to energy used of the user

TABLE VII

SIMULATION SUMMARY

No. of installed PV solar Systems per year	100,000
Total installed power per year (MW_p)	565
The delivered energy per year (GWh)	600.9
The total supplied energy cost in case of traditionally generated ($ annually)	132,198,000
The average decreasing in CO_2 emissions per year, in case of conventional power plants generation (tons)	390,585
The average decreasing in CO_2 emissions per year, when using common backup generators (tons)	480,720
Averaged daily installed PV systems (250 workdays a year)	400
No. of installation teams (3 technicians each team)	264 (792)
No. electric technicians' team (2 technicians each team)	132 (264)
(Job offers, No. of expected trainees)	1056
The total PV systems estimated cost million Dollar	430
Total estimated cost of installation, $ (Based on 300 $ each)	30,000,000

B. Benefits into GECOL's Grid

Installing 100,000 rooftop solar systems means adding 565 MW to the installed capacity generated power. According to GECOL, the household sector is the largest energy consuming side, as it reaches 51% of the total sold energy [7],[8]. Therefore, targeting such sector is achievable by rationalizing and installing rooftop solar systems. It will have a realistic impact in terms of covering some of power demand besides enhancing grid stability.

C. Environmental Benefits

According to [1], the average efficiency of the currently operated power plants in the Libyan public grid till 2022 have not exceed 33.3%. This means that 66.7% of the consumed fuel in power plants are wasted, and the lost rate reaches about 2275 million of the fuel subsidies assigned to the GECOL in the same year. It results an emission of about 23 million tons of CO_2.

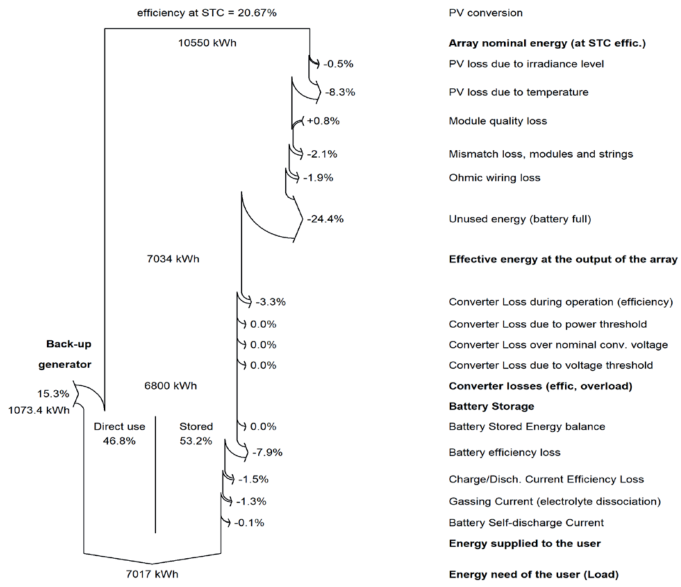

Fig. 10. PV system losses diagram

The installation of 100,000 rooftop PV solar systems reduces the CO_2 emissions to approximately 390,585 tons annually in case of completely generated by conventional power plants, and at least 480,720 tons when using common backup generators.

D. Libyan Government's Benefits

According to the simulation results of proposed system, the annual installation of 100,000 systems will generate 601 GWh of solar energy, which will save the state of Libya an estimated of 132 million $ annually. It was frequently spent to generate the exact amount of electric power through traditional power plants. Therefore, based on fuel international prices, the state of Libya will effectively be able to reimburse roughly 132 million US Dollar within 39 months. In addition, Libyan government will get indirect gains such as, get banks involved on investment sector as well as refreshing labor market, activate the participation of private companies. The research centers and advisory institutions will share data collection and attempt to develop such new technology.

X. The Proposal Implementation Approaches

- Preparing an electronic system, which operates via ship that has the owner information, and can be accessed by third party authorities. That could be done as following:

✓ The citizen or beneficiary, announcing to people who are willing to acquire the system through a link created for this purpose then they can register online. The costumer will be able to follow the installation procedures according to announced date and time.

✓ The company, which is the authorized public authority responsible for the supply, sale and guarantee the solar systems.

✓ The bank is responsible for financial procedures, clearing and financing if required.

✓ -Installation and connection (provided by private companies): represented by the installation teams of private companies.

✓ Inspection and supervision: Both are a duty of a third party who authorized and responsible for pre-inspection, verification of the systems installation. Accordingly, they are responsible for training teams to study and analyze the operation data.

- ✓ Collection: the GECOL is responsible for verifying the payment of debts incurred by the costumer.
- ✓ The supporter (Libyan government): It should pay the price difference, whether in relation to the exchange rate or the subsidy rate.
- ✓ Follower (the third party): It is the entity responsible for managing the process through the electronic system and legal and spatial follow-up remotely.
  - Public announcement for project applying conditions for the solar systems, and inviting people who is willing to own one of those system referenced. the people who is willing to obtain those systems register through the announced link enter their information, including: a username and a password, to follow the procedures. Accordingly, they enter to waiting list and they obtain an indication number to follow-up with the procedure. Inspection teams communicate with cases that automatically appear on the side of their system, and set an appointment to visit the installation site. If the installation site is not valid (no enough space, shadow, or any other condition makes the site not valid for installation), the case will be removed from the waiting list and the system will send an apology letter to the costumer via phone. Once site is suitable for installation, the result is documented on the system to appear to the rest of the parties responsible in the process, hence a message will be sent to the customer to review the funding steps.
  - The case remains in the waiting list until the customer settles his debts with the GECOL.
  - Based on the result of the inspection and collection teams, the solar system is initially reserved within the company's list automatically then the process appears on the side of the bank's system and a message is sent to the costumer that he has an appointment at the bank.
  - The customer contacts his bank to complete the procedures for withholding the price of the system from his account, or requesting lending according to the financing methods provided by the bank.
  - The bank transfers half price of the solar system to the company's account, thus making the final reservation. Then, the case appears in the company's waiting list as well as installation teams. The claim is sent to the supporting party to transfer half of the subsidy value to the company's account, respectively.
  - The installation teams receive the solar systems and communicate with customers to complete the installation process according to the lists that appear to them in the electronic system. The installation team submit a report about the installation at the electronic system whenever they done their job.
  - The inspection team will follow up with the report who will be responsible of installation safety and observing the operation conditions as well as train the costumer dealing with the system.
  - The inspection team has to submit a report to the electronic system once they done with their job. Then, the bank and the supporting party have to pay the rest of the dept to the company's account which is going to pay the installation costs.
  - Finally, the company issues the manufacturer's warranty document for the solar system that starts at installation date of receipt and provides the after-sale provision services for a period not less than the warranty period.

XI. Conclusion

This paper introduced three Scenario of PV rooftop systems appropriate for Libyan household's appliances. Models of typical Libyan homes appliances were considered. It ended up with a proposal of hybrid PV solar system that should be widely installed. Therefore, it can be summarized that system with a nominal capacity of 5.65 kW_p and run to supply an annual energy estimated at 7.017 MWh, with a solar contribution rate of 84.7%, will clearly minimize the consequences of Libya power shortage. Since 100,000 PV systems are highly recommended to get it installed annually, it thus generates 601 GWh every year. Consequently, the project can simply reduce CO_2 emission by 390,585 ton yearly. Furthermore, it will aim to save 132 million US dollar every year which Libyan government afford to support GECOL with for burning fuel. The growing of PV systems creates power reserve which indirectly extend electric grid equipment lifespan. Therefore, the project will successfully strengthen the awareness of power grid independency. Nevertheless, the Tariff of 0.082 $/kWh should be certainly updated in terms of power saving and sustainability enhancement.

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