

# Impact of Solar Energy Based Power Grid for Future Prospective of Pakistan

Muhammd Usman Sardar, Mazhar Hussain Baloch, Muhammad Shahbaz Ahmad, Zahir Javed Paracha

**Abstract**—Shortfall of electrical energy in Pakistan is a challenge adversely affecting its industrial output and social growth. As elsewhere, Pakistan derives its electrical energy from a number of conventional sources. The exhaustion of petroleum and conventional resources, the rising costs coupled with extremely adverse climatic effects are taking its toll especially on the under-developed countries like Pakistan. As alternate, renewable energy sources like hydro-power, solar, wind, even bio-energy and a mix of some or all of them could provide a credible alternative to the conventional energy resources that would not only be cleaner but sustainable as well. As a model, solar energy-based power grid for the near future has been attempted to offset the energy shortfalls as a mix with our existing sustainable natural energy resources. An assessment of solar energy potential for electricity generation is being presented for fulfilling the energy demands with higher level of reliability and sustainability. This model is based on the premise that solar energy potential of Pakistan is not only reliable but also sustainable. This research estimates the present & future approaching renewable energy resource specially the impact of solar energy based power grid for mitigating energy shortage in Pakistan.

**Keywords**—Powergrid network, solar photovoltaic (SPV) setups, solar power generation, solar energy technology (SET).

## I. INTRODUCTION

FROM the start we are quantifying the environmental quantity using several indications and their trends. For suppose the undesirable gas emissions in combustions of many conventional fuels and energy resources. From 1950s to 1990s, our overall domain has lesser carbon and other environmental destructive emission due to alertness in consumption and provision of control in emission [1]. Hence it is well proven fact that environmental qualities as some of above discussed will be subjective to the level of World's energy consumption [2]. In the similar way agriculture production have also greater dependency on higher use of energy [3]. The resources of energy can be categorized into renewable and non-renewable systems viably. First one is considered to be very environmental friendly while other one

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sources of energy are exhaustible in universe and also causing source of pollution being harmful for our environment.

Renewable means of energy are solar, wind, biomass, micro and mini hydro, geo-thermal, tidal, ocean wave and thermal resources of energies around the worlds. Lunar or solar driven energy is one from renewable everlasting and inexhaustible means of energy i.e., effectively accomplishable to fulfill a major percentage of the world energy need. It is being utilized in solar photo-voltaic or direct conversion and solar-thermal; that are solar concentrated forms to generate the electricity. The solar energy reached at earth place is nearly equal to  $700 \times 10^{15}$  units (kWh) in each year [4]. The through-going solar photo-voltaic energy extracted on surface is from  $7 \text{ kWh/m}^2$  per day. Nevertheless, it is encountered to nearby of equator on a clear day at the noontime [2]. For a vibrant climate day, this irradiation is almost 90 percent direct on average, and on cloudy days it could be 100 percent diffused. So these two components form the total striking radiations. In year 2005 and afterwards total practice of energy consumption was  $0.135 \times 10^{15}$  units [5].

Location of Pakistan is also blessed with these unlimited sources of energy and they are to be extracted-out with higher level of interest using optimized and appropriate techniques for direct energy conversion.

According to the statement of problem of energy shortfalls being faced in Pakistan, authors describe that there is higher dependence on biomass energy. Almost 66.6 percent populace, living in rural area, uses firewood, dung and crop residue and other conventional resources to fulfill everyday energy requisite. Now it is estimated that biomass energy have 27% consumption on overall energy mix of electricity, over-exploitation of forest resources without any necessary consideration, harvesting the heavy imported petroleum products, and less privation on the feasibility of renewable sources of energies [6]-[8]. This paper discusses many aspects of world's energy scenario and especially of Pakistan for the impact of harvesting the solar energy technology as point-to-focus. Ordinary, the country Pakistan receives 7.5 hours of sunlight per day with average solar radiation equal to  $6 \text{ units/m}^2$  (1unit=1kWh) in a day along-with 0.85 persistence factors on 95 percent of its areas[10]. In earlier days this country was deprived of to the usage of energy potential but in 1991, government took interest to develop the technologies and hence many departments, boards, corporates, companies, international investors were endorsed for its usages.

## II. RECENT STUDY REVIEWS IN SOLAR ENERGY PROSPECTIVE

Ahmad Bilal Awan [16] deduced that renewable energy potential is a vital part to minimize the current energy crisis being faced in Pakistan. Now modern societies are more curious about environmental cleanliness and sustained energy supply in its continuous usages. Exiting production of renewable energy through different renewable energy technologies is being discussed and the potential capacity of production of energy through these technologies in Pakistan is studied. Hassan A. Khan [17] presented high-technological reviews on solar photo-voltaic (SPV) in Pakistan for its utmost scope, performance evaluations and endorsements for it reliable system design. It includes the discussion about recent state of affairs, current focus towards the technological deficiencies and shortcoming being faced today. They highlighted numerous inefficient in solar photo voltaic system design that is responsive to un-optimized and unreliable systems. Also proposal is being added for modification that could be added to design process of solar photo-voltaic (SPV) setups to make it more aquatinted. Hafiz Bilal Khalil [18] investigated the relationship between the energy and demand supply in Pakistan and evaluated the real reasons behind the current energy crises. According the provision of renewable energy potentials we can find supplementary and alternate energy sources to cut down the load on the national energy mix selecting the different areas.

Anjum Khalid [19] evaluated the economic viability of solar photovoltaic (SPV) based power plants. Accordingly, best site selection and proposed location for this project is estimated by comparing the monthly and daily average global irradiation data of different Pakistani cities and city Quetta, Pakistan is probably chosen for the mega-watt power plant in responsive to results by software through RET Screen simulation. Ishan Purohit [20] claims the progressive role of implementation of concentrating solar power (CSP) in development of India energy sectors. They estimated on the basis of a detailed solar radiation and land resource assessment, the maximum theoretical potential of concentrating solar power (CSP) in North-West India is estimated over 2000 GW taking into accounts the viability of different CSP technologies and land suitability criteria.

Govinda and Ameer [21], [22] analyzed preferred selection of renewable energy technologies for Pakistan by considering altogether renewable energy prospective available. Authors proposed a decision model that is used for the development of long-term renewable energy policy and energy roadmap for the country besides. Mohammad Azam [23] discussed the environmental friendly solar energy scenario of Pakistan. Research work being made in the field of solar photovoltaic (SPV) technology directs iturgent implementation on priority basis. Waheed Bhutto [24] discussed the issues and challenges in implementation of green energy projects. Solar power, as being a hottest area in energy in Pakistan, needs imperative venture, but it need debate about the future technology and markets. Research study explores the evolutional challenges for solar photo voltaic affording to the overall concept of alternate and sustainable development. Haris Jawaid [25]

provides research and development on solar powered uninterrupted power supply in market of Pakistan to cope-up the alternating energy source necessities of offices, industries, households. It includes the analytical design, research organizations used and the conclusions in marketplace study during the research. Neha Adhikari [26] presented a research study about modeling based design and control of remote solar photo-voltaic energy generating station. The proposed designed for delivering an average electrical load. This solar photo-voltaic (SPV) energy setup is designed, modeled and its evaluated performance is simulated in the Mat-lab software laboratory. This feasible setup is presented for different type of line loads.

Prabodh Bajpai [27] presented the feasibility for extraction of maximum energy from the solar positioned data. Continuous movement of the earth alters the solar radiation concentration received on solar accumulator. In his work, solar auto-tracking mechanism has been devised using light depending resistor sensors and direct-current motors motion control on a mechanical structure with some gear based arrangement. Hence the proposed design increases efficiency of PV setup and improved sustainability. Liu Jian-Hua [28] compared between independent system and grid-tied setup and studied about solar battery assessment, Solar photo-voltaic power generating stations in domestic railway stations with different proposes two schemes. Considering the factors of socio-economic viability, saving of energy, environmental issues, optimized scheme is finalized.

## III. OVERVIEWS IN ENERGY CONSUMPTION IN PAKISTAN

Pakistan energy sector scenario comprise of usage of electricity the others sections alike in domestic, commercial, industrial, agricultural and transport etc. Domestic usage is at maximum level and after that second level of usage is in industries. Now a day's socio-economic growth of Pakistan is mainly very destructive dues to energy outage from early 2000s. Faster growth-rate of population with growth rate of 12 percent in the year of 2012-2012 [11], lack of improving and redevelopment of energy generations plans and other reasons encountered likewise international circular debt, weal financial position, higher dependency to the imported hydrocarbon products and un-utilization of energy potential available are some nominated constraints logically reasonable for the sever energy shortfalls [7]. Tables I and II show the sector wise energy usages and energy mix dominating for different years.

## IV. CURRENT DEMAND SUPPLY SITUATION IN PAKISTAN

At present capability of electric power generation is much below the installed capacity. Mainly this is due to variations in availability of water resources as preference is given to the agricultural use, deficiencies in natural gas resources, and inadequacies power generation of public sector plants and their breakdown in excess even efficiencies in some plants are 24% or below [15].

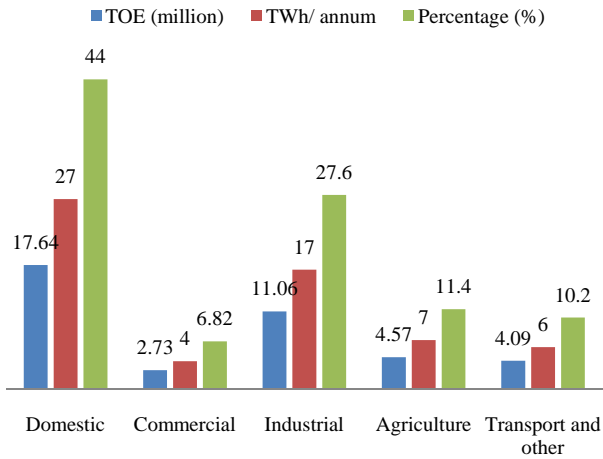


Fig. 1 Energy consumption in Pakistan [7]

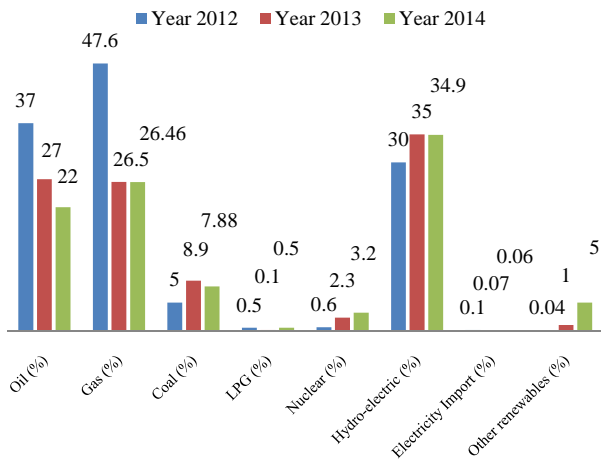


Fig. 2 Total Energy mix of Pakistan for different years [8]

Some plants are now a day's maintained up-to maximum level and refurbished through involvement of United States-AID and other international aid programs. Even now a day there 10-14 hours load-shedding in urban areas and eventually power outage increased up to 16 hours in rural areas. Though Pakistani government is trying at utmost environment to balance the energy demand but presently the status is depicted in Fig. 3 from the year 2012 to year 2025[8]. Currently,

Pakistan is suffering deficit of energy of 14 GW from for sources of generation. Government of Pakistan is now taking interest in balancing the energy demand-supply with ongoing plans by importing technology, electricity and validating the concerned policies against alternate and renewable energy resources.

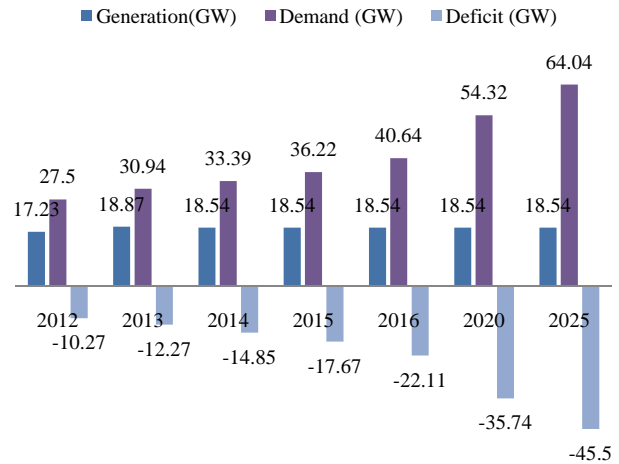


Fig. 3 Pakistan electricity forecast supply & demand position [8]

#### IV. GLOBAL INVESTMENT IN MARKET OF CLEAN ENERGY TECHNOLOGY

Internationally, usage of renewable energy potentials using appreciate technologies is point of focus of many countries now a days. Fig. 4 shows the global total new investment in harnessing the clean energy. In 2011s, many of countries invested their maximum of revenues in implementing the renewable energy resources. The overall cost was \$ billions with 34 percent increase in investment. Prescribed total investment includes corporate institutes, government R & D (research and development forum) forums (research and development), distributed companies and local investors [19]. Fig. 5 shows the individual countries interest in development of clean energy. China is at utmost attentiveness in implement the renewable energy techniques internationally.

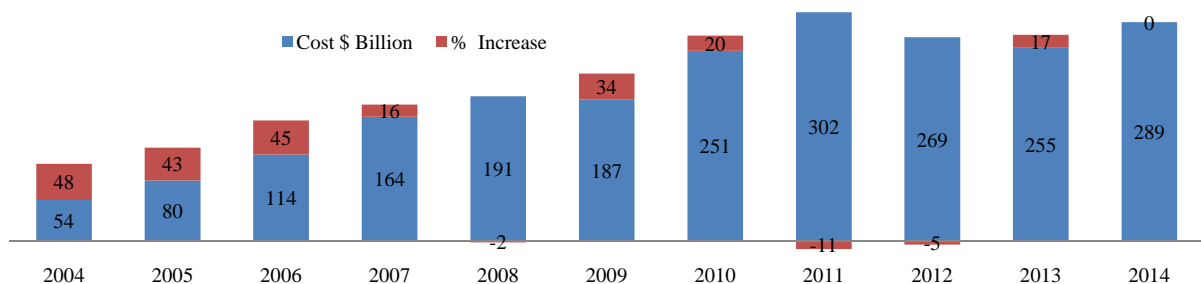


Fig. 4 Worldwide cumulative investment for development of clean energy [16]

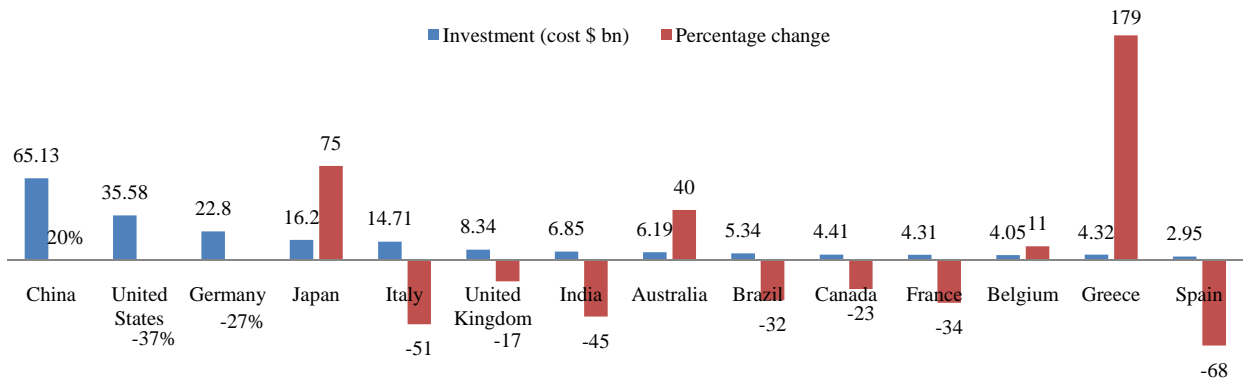


Fig. 5 Investments by top countries in development of clean energy for 2012 & percentage change for year 2011 [9]

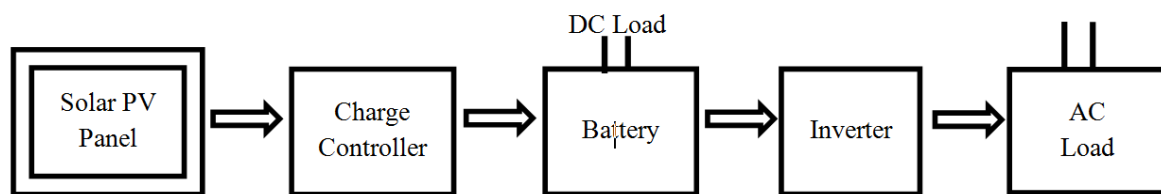


Fig. 6 Schematic stand-alone photo-voltaic generation setup

In 2011-12, in international market solar have highest investment level that was 140 \$bn with a decrease of 11%. Investments on effective utilization of wind, biomass & waste, small hydro, biofuels and geothermal, marine energy resources are 80 \$bn, 9 \$bn, 8 \$bn, 5 \$bn, 2 \$bn, 0.3 \$bn respectively along-with -10%, -34%, +20%, -40%, -44%, +13% growth rate from the year 2011 respectively [8].

#### V. SOLAR ENERGY TECHNOLOGY AND TOPOLOGY FOR ELECTRIC POWER GENERATION

This section explores the solar photo-voltaic (SPV) technologies for the understanding and relevant issues in implementations. They are examined as mainly divided into two subparts as SPV and other one is concentrated solar thermal systems (CSTS) [17]. We will discuss only solar photo voltaic (SPV) technology that is dedicated to direct electrical energy (DC current) conversions from the sun-lights. Solar photo-voltaic generated power setups are rated in peak kilowatts (kWp) and that expected amount is to be delivered to electrical loads being connected and PV arrays are exposed to sunlight. Due to currents issues in decrease in prices and world clean energy interest and an investment, policy is amended for its implementations throughout the world. Decreasing trends in cost of Solar photo-voltaic, author focused on state of affairs on solar photo-voltaic in Pakistan [24]. Following solar electric power schemes are nominated namely as;

- A. Grid-Connected solar Energy setup
- B. Stand Alone setup

##### A. Grid Connected Solar Energy Setup

This is first main type of photo-voltaic setup. This on-grid system is directly connected to grid and injects the directional electrical power into the conventional national grid networks.

Accordingly, DC power is generated by solar photo-voltaic panels and it is converted into alternating current scenario viable with grids systems. Moreover, solar photo-voltaic power setups can also be operated alone and hence they are called self-governing, or autonomous systems. Moreover 90 percent solar photo-voltaic setups are grid-connected systems [17].

##### B. Stand Alone Setup

This one is most relevant topology for energizing of off conventional power grid-network & stand-alone solar PV power generations. These solar setups may be implementable in suburban, rural or remote electrifications of areas. Fig. 6 shows typical solar PV installation setup for generation of electricity; however the detail is discussed in next section.

#### VI. STAND-ALONE SETUP FOR BACKUP AND DISTRIBUTED GENERATIONS

These setups are used in individual manners to energize the power systems. Solar panels/modules are simple in design and require only little maintenance with inferior running cost. It's being advantageous in constructions; as off grid or stand-alone solar PV setups giving direct electrical power from fractional-watts (W) to giga-watts (GW). Consequently, they are beneficial to be used as electrical power supply, for pumping of water and sanitation, buildings and remote locations and domestic use etc.

##### A. Solar Photo Voltaic Panels (PV arrays)

The solar cell is elementary entity of photo voltaic technology. Solar cells are finished with semi-conductor, silicon, with loosely attached electron live in valance band. In the event of "conduction", the valance band electrons gain

leveled threshold energy is broken down and free electrons move around free energy bands called conduction band. The energy prerequisite to free electrons for the shell is provided by photons, i.e., solar light [12].

Solar cells are bifurcated into two dominating technologies; single/multi-crystalline (wafer type) and thin films (a Si/ Cd Td/CIGS). First one wafer-type technology is developed from wafer cut from a Si ingot and these cells are dominated 98% of commercial photovoltaic market. Latter is fabricated by dumping Si (Silicon) directly on to a substrate material like a glass or steel [24]. The nominal arrays of solar cells are coupled electrically and housed on single-support structural frame that is called a 'Photo voltaic module/panel' supplying with certain voltage level. These modular panels are then connected in series or parallel fashion for different setups to generate required voltage (Volts) and current (Amperes) combinations.

### B. Solar Charge Controller

A charge controller is electronic circuitry device called dc-dc chopper and dedicated to charge the batteries bank from solar panels and to derive the load with a nominated voltage level. DC output of PV arrays changes all the day with the change in irradiation of exposed light. This charge controller is used to have optimized charging mechanism the battery by stepping-down the voltage pressure level. According the working division of these controllers, they are categorized in PWM and MPPT charge controllers [17].

### C. Battery Banks and Energy Storage Systems

This part of solar PV setup is mass energy storage system in battery banks that are connected in nominated predefined assembly to get the desired voltage/current ratings and ampere-hour capacity of the storage systems. Lead-acid or electrolytic based batteries are the primarily used in solar photo-voltaic setups. Other types of batteries used as accumulators are; flooded AGM type and gel based lead acid battery.

### D. Inverters for Single Phase or three Phase AC supply

Inverters also comprise on electronic circuitry used to invert the direct current (DC power) to alternating power. Mostly in Pakistan the inverters are designed for line AC values of nominal voltage and current ratings of the equipment that is 240 V<sub>rms</sub> and 50Hz ac frequency. There are various other topologies on inverters redeemed to derive the ac loads. On the basis of resulted out wave shapes they are classified into following categories

1. Squared wave inverted
2. Modified sinusoidal wave inverter
3. Pure sinusoidal wave inverter

Square wave inverter is simple in constructions and least efficient. They contain large harmonic contents and can cause interference electromagnetically and inductive components loss.

Modified sinusoidal-wave inverter is at commonplace in efficiency and performance.

And last one type has least harmonic components, but in-comparison they are very expensive and primarily used for on-grid type solar PV system.

## VII. SOLAR MODULE PRICES FOR DIFFERENT PERIODS OF YEAR

Solar energy cells and technology products have set to decrease in its price for the year 2010. In every 3 months its pricing are reduced to 30 % and it is penetrating in local markets to affordable for very common persons as indexed in Fig. 7 [4].

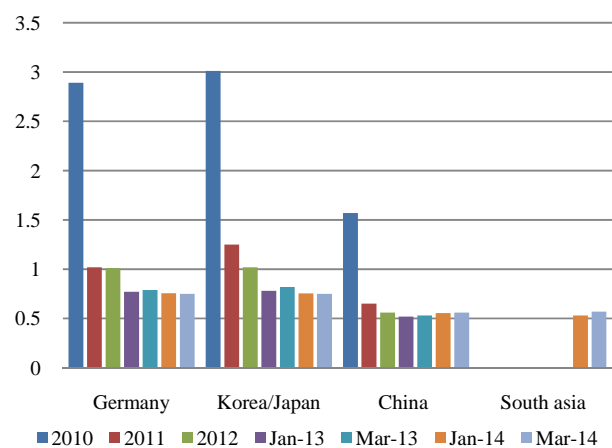


Fig. 7 Photo-voltaic cell experience pricing [4]

In China, in 2010, total Solar PV installed capacity has reached to 20 GW but that was predicted to be 2 GW early is 2000 as being optimistic prediction. The European PV industry association forecasted in 2000 that 2.00 GW of PV will be installed by year 2010, but in actual, 40 GW were installed.

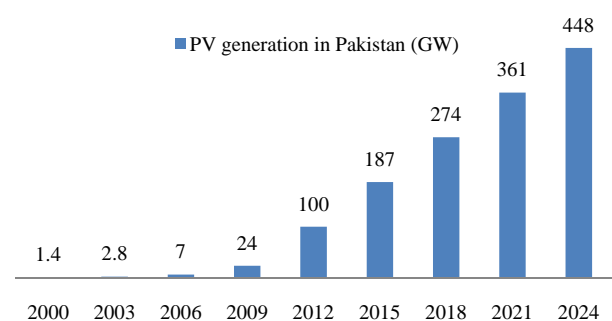


Fig. 8 Solar PV Global capacity forecast 2000-2024 [16]

## VIII. ENERGY STRATEGY BY THE GOVERNANCE OF PAKISTAN AND ALTERNATE ENERGY ISSUES AND IMPLEMENTATIONS

Historic background factor affecting the current electricity stare are such as stable policies, introduction to new innovative technologies, resulting cost reductions, increase in capital investment in renewable energy implementation have often driven stronger market uptake than anticipated.

Numerous studies and other methodologies are conducted with bylaws defined by government and some other global institutes corresponding to Asian Development Bank (ADB) and World Bank for meeting the meeting the energy demands present and future wise. Due the majority of reasons mentioned above are being significances to develop the mega structure dams. Some of them are under construction like Khan Khawar, Allai Khawar, Neelem Jehlam and Jinnah megaprojects. Government issued mega projects viable for the energy demands of country and importing it to other neighborhoods [13].

Before the construction of these projects, implementing the renewable or non-conventional energy, especially solar energy based grids, can offset the energy demands of domestic and other users to maximum of its extent. In 2012 National Renewable Energy Policy, with cumulative permission to the committee, announced the targets being set to utilities the maximum of 3% share of renewable energy in national energy mix, share of 2% in annual development budget for development of Alternate Energy (AE) technologies, and connecting the AE based power grids wit national grids. From the year 2000, Pakistan took interest in development of Solar PV technology and currently generation capacity is 120 GW from all the resources being imported and utilized also ongoing solar technology utilization provision is being shown in Fig. 8. Fig. 9 exploits the implementations and circular development of solar photo-voltaic panels. Now it's being very common to use individually or collective to generate the fractional Watt to Mega Watt electric power generations [9]. In proceeding, government of Punjab is working on numerous alternate energy projects to solve the energy outage issue up-to maximum level.

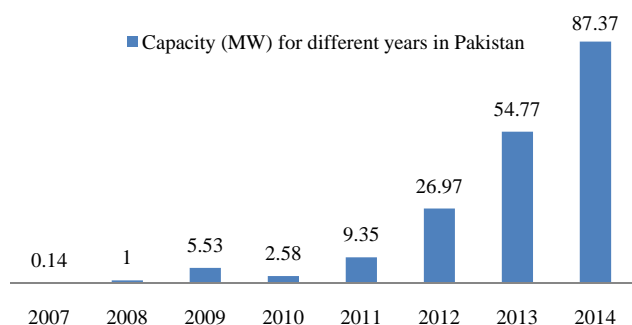


Fig. 9 Year wise import of solar panels capacity in MW [12]

#### IX. IMPLEMENTATION OF SOLAR BASED POWER GRIDS

We have taken out a case study for the deployment of domestic grids in supplying individually or Wapda hybrid energy balancing schemes. In selection of replacement of solar energy based setups we are in consideration to the following ways-out;

- Solar panel Selection
  - Mono/poly crystalline or thin film solar Photo-voltaic
- Estimation of costs for each design options
  - For domestics, industrial commercial and load according to rating and deriving hours

- Efficiency Improvement from setup
  - 12/24 or higher voltage setups and account for efficiencies of entities
- Cost estimates for each design option
  - Initial cost, running cost
- Cost verses efficiency
  - Paybacks
  - Savings of energy and facilities
  - Statistical prescription

#### X. FACTORS AFFECTING IN EFFECTIVE UTILIZATION OF POWER GRIDS

In accordance with the solar energy potential available in implementing the technology, several factors are taken in account likewise capitals, technical competencies and skills in hands, affordability of common man, and ongoing interest in solar based energy technology [14]. Availability and affordability with preceding packages and pricing are shown in Table II that shows the complete picture of solar energy based grid setups. Variety of solar setups is available in Pakistan market and internationally viable for the deployment in constructing the solar power grids. Mono-crystalline and polycrystalline are in ease to be available in Pakistan's market. Consider the case study for different setups in replacement of existing WAPDA power supply in Table I having comprehensive comparison.

TABLE I  
 EVALUATION OF DIFFERENT SOURCES FOR 1-KVA TYPICAL SETUP

	PV Panel	Generator (Gasoline)	Wind Turbine	Wapda setup
Price (PKR)	75,000	1,11,000	1,20,000	10,000
Fueling (PKR)	Nil	12,230	Nil	3,700
Life span of setup (years)	25	4-5 years	10-15 years	Nil
Maintenance cost (Rs/h)	Nil	6.5	3.5	1.5
Carbon monoxide	Nil	6.5g/Liter	Nil	Nil
Un-burned hydro-carbon contents	Nil	0.72g/Liter	Nil	Nil
Nitrogen oxides	Nil	58g/Liter	Nil	Nil

#### XI. SIMULATION OF SOLAR PHOTO VOLTAIC SETUPS

Considering the case study real time data of solar photo voltaic setups as depicted in Table II, their performance is simulated in different rating scenarios. Power output, efficiency of conversion, efficiency of Photo voltaic module. Solar charge controller efficiency, overall efficiency, installation costs, average units (kWh) generated per month, savings in implementing solar energy rupees, initial costs and paybacks year are presented. This particularized table shows that we invest some initial cost the start in implementing the solar PV setups; we will get benefits in continuous electric supply, no fuelling or billings per months and reimbursements after the paybacks of initial investments.

#### XII. STATISTICS OF SURVEYS

In view to the solar PV setups, public and private responsiveness is likely to be favourable is use this technology

further. The frequent load-shedding and failure in continuous power energy lead the philosophy of common man to use these solar PV setups. Table III shows the different plans acting towards the implementing these setups. The following key points are milestone in this solar energy technology (SET) and expected to have favoured deliverable.

- No of persons get willingly awareness about the solar PV energy techniques and facilities accordingly based on services

- Responses from people to get information from focal person, positive or negative
- No of person perusing to use solar energy in future to get this facility for their locations or area
- Actual no of persons using the SET in their respective domestic, commercial, industrial or agricultural usages
- Rate of implementing the SET that defines the acceleration of adoption of solar energy systems facility.

TABLE II  
PERFORMANCE CALCULATIONS OF DIFFERENT SOLAR ENERGY SETUPS

Solar Setups (kVA)	0.5	1	2	3	5	10	20	50	75	100	150	200
AC Power Output (kW)	0.25	0.56	1.20	1.81	3.09	6.39	12.97	34.08	52.79	71.87	111.17	148.22
Efficiency of inversion (%)	95	95	95	95	95	95	95	95	95	95	95	95
Efficiency of PV Modules (%)	97.5	97.5	97.5	97.5	97.5	97.5	97.5	97.5	97.5	97.5	97.5	97.5
Controller Efficiency (%)	55	60.53	62	65	67	69	70	74	76	78	80	80.02
System Overall Efficiency (%)	50.1	55.8	60.2	60.02	61.74	63.92	64.83	68.19	70.39	71.87	74.10	74.11
Installation cost/watt (PKR)	70	75	80	90	100	120	120	120	120	120	120	120
Average generated KWh/month	48.75	109	234	353	602	1246	2.53k	6.64k	10.29k	14.01k	21.67k	28.90k
Saving using SET per month (Rs.)	390	1308	3276	4942	8428	17.44k	35.42k	92.96k	142.8k	196.14k	303.4k	402.6k
Initial Cost (Rs)	35k	75k	160k	270k	0.5mn	1.2mn	2.4mn	6mn	9mn	12mn	18mn	24mn
Payback (year)	7	4.7	4	5.5	5	6.8	5.6	5.4	5.3	5.1	4.95	4.96
Revenue Generated	84.24k	318.6k	825.6k	1.2mn	2.0mn	3.8mn	8.26mn	21.86mn	33.76mn	46.84mn	72mn	96.67mn

### XIII. AWARENESS PROGRAM FOR PROGRESS IN IMPLEMENTATION OF SOLAR ENERGY TECHNOLOGY

They are described as;

- Awareness through pamphlets, play-card, banners, advertising outfits regarding the cost-benefits scenarios.
- Meeting with resources persons in rural areas in local community for awareness and benevolent development in agriculture, remote and sub-urban areas and publicity through media
- Demonstrations of solar energy technology practise and appliances in rural areas for development of SET in domestic and other usages of electricity
- Publicity through electronic & print media versions
- Solar energy wakefulness seminars to people for its know-how and importance regarding its sustainability, easiness, reliability and continuity around the clock.

### XIV. SOLAR RESULT IN PAKISTAN FOR THE FUTURE

On behalf of a prospective Pakistan, we plan to utilize 100% renewable energy resources using all of its utilities like

solar thermal, photovoltaic, hydro, biofuels, biomass, geothermal efficiently. These cumulative plans will integrate solar parks in nominated areas as some of it is already established in Quaid-e-Azam solar park, Bahawapur (QA Solar, Pakistan) as well as the combined wind farms on coastal line of Sindh and Baluchistan. A running project of 2000MW is in progress signed with Asian Development Bank and its expected year of competition is 2015. Companies from China and Turkish are very concerned to harvest the maximum solar energy potential. Also in a view of progressive interest, China power investment crop (CPI) is showing intense interest in 4 power projects. Currently projects of 660 MW power and 300 MW power plants will be installed in Lahore and Bahawalpur. Individuals are to be conversant to use maxim of their own energy generations methodology using this solar energy technology in comparisons with other conventional fuels. People should be significantly wanted to increase the amount of renewable energy in their energy mix, which is minimum of 2 percent onto the total electricity resources.

TABLE III  
PERFORMANCE CHARACTERISTICS ON CASE STUDY DATA

Nomination	No. of People	Oct 2013	Nov 2013	Dec 2013	Jan 2014	Feb 2014	March 2014	April 2014	May 2014
(A)	Awareness given	498	1000	1400	2400	3245	4245	8945	15000
(B)	Comebacks from people	250	750	798	1464	2109	2444	6441	10800
(C)	People perusing to use SET	15	53	63	146	274	367	966	1620
(D)	Actual figure-out using the SET	3	9	13	34	68	99	295	585
(E)	Rate of implementing the SET (%)	0.59	0.90	0.93	1.42	2.09	2.33	3.3	3.9
(F)	Satisfactoriness of users (%)	NA	NA	NA	NA	10	13.5	46	52
(G)	Future enhancements plans (%)	NA	NA	NA	NA	10	43	76	80
(H)	Average Units generated per month	299	870	1430	3.7k	7.8k	11.4k	35.3k	70.2k
(I)	Total Units consumed by wapda	4593k	4602k	4789k	4885k	4901k	4975k	5576k	5478k

## XV. CONCLUSION

In account to its advantages and beauty of its setups it is becoming a milestone to resolve the current energy issues being faced. Solar energy is harvesting in all the areas concerning to electricity demands in domestic, industrial, commercial and agriculture and others in the Pakistan. These loads can be cleaned to direct solar setups which could lessen the demand of electricity. These solar photo-voltaic (SPV) setups can also be used in others countryside where periodic load-shedding can be easily accommodated by these SPV setups with un-interruptible electricity. In-addition every local or multinational enterprise, industrial or commercial patrons can use these alternate energy backups rather than conventional non-renewable fossil based generations. These way-outs will surely lessen carbon- C and other destructive emissions and adding up in efforts to reduce it thoroughly.

Pricing of solar photo-voltaic technological setups are cutting down by the initiative taken by government such as harnessing the solar energy potential, indigenization, relief in custom duty on its import. Bu publicizing its effectives in Pakistan, we can install its solar photo-voltaic setups on domestic, commercial and industrial level. Pakistan Council of Renewable Energy Technology (PCRET) is working to fabricate the cost-economic design at trial-scale meanwhile imported solar panels are available in the market but at outrageous pricing. So at current phase, Government has to provide enduring plans and supporting policies to meet the long targets to build-up assurance for investment in engineering capacity and deployment the solar PV setups.

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