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RESEARCH ARTICLE

DISTRIBUTED ENERGY RESOURCES:ISSUES AND CHALLENGES.

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Abstract

It is noticed, a hike in percentage over the smart grid interests in producers and consumers. In order to meet the requirements of the consumption of power we need to increase the use of renewable energy resources. Distributed Energy Sources (DER) is quite attractive way of distributing energy. It has got great future scope in distribution area. In the present paper the characteristics, advantages and disadvantages of various DER sources is discussed. The challenges and issues of DER are also described and addressed the problems that arise in existing grid.

Introduction:-

As increasing demand of electricity in today's era, losses reduction, efficiency enhancement and making grid environment friendly are the necessities. Electricity must be generated, dispersed and distributed in real time. It is required to manage demand and supply in real time as well as ensure stability and power quality to consumers. Smart distribution is distributing energy in a smarter way. One of smarter approaches of distribution is, using micro grids concepts. Micro grids can be functioned in two different modes named as; connected to a grid and stand-alone mode. One of the main attractive features/advantages of these microgrids is its generation facilities, which could be centralized. This helps to provide the smaller and additional dispersed energy resources way and support to overcome the losses of traditional methods on economic scale [1]. Distributed energy resources (DERs) are small power resources, like solar photovoltaic, cogeneration systems, wind turbines, micro turbines, backup generators and energy storage devices that can be aggregated to meet the regular demands. It provides energy where ever it is needed [7]. It also provides the less expensive and fast option as compared to the large structured power plants. Usually, DER producing less than 10megawattenergyand is installed for meeting particular needs. DER system includes wind turbines, photovoltaic system, fuel cells, gas turbines, micro-turbines, internal combustion engines and energy storage system, which helps to enhance the operating ability of the electric grid independently. They are installed adjacent to the electricity consuming units such as home, business etc. and offer an improved alternative to the traditional electric power grid. DER is designed to distribute energy in smarter way to enhance the reliability, reduces cost, increasing efficiency and to meet the future demands of consumers.

Distributed Energy Resources (Der):-

A gradually refinement have all been occur in the DER technologies from the past several years. New technologies are highly efficient than the previous ones; therefore a replacement or upgrade may pay for itself sooner than expected. Also, safety of energy is a major issue at many Federal facilities. In those specific cases, DER systems can power mission-critical loads, reduce hazardous or costly power outages, and diversify the local energy supply [2].

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Bring sources closer to the loads contributes in reduction the heat losses and transmission cost. Existing grid allows one way communication whereas micro grids allow two ways communication as shown in Fig 1 and 2 respectively.

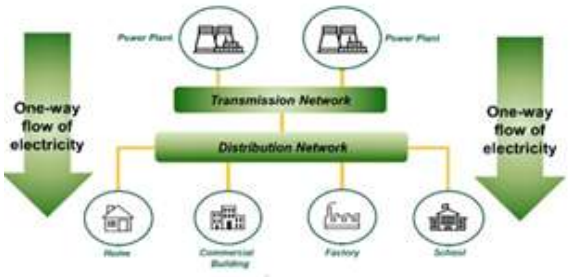

Figure 1. Today's Electrical grid

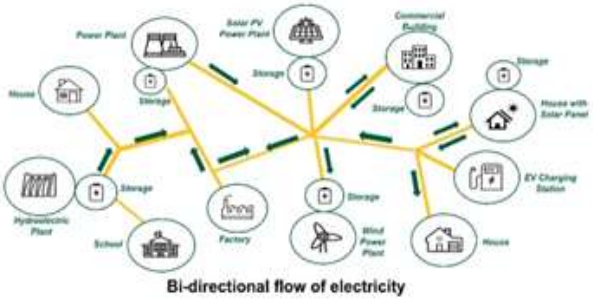

Figure 2. Tomorrow's Electrical grid

The DER system is capable enough to enhance the safety of the bulk power system by confining overcrowding, loop flows, high losses and cascading effects. Specifically, due to the decentralized nature, the distributed resources enhanced the considerable consistency of the system as a whole by making power supply less dependent on the bulk transmission network.

Some DER sources such as micro-turbines, fuel cells are easily controllable, while others (wind and solar energy) having highly unpredictable power output. This necessitates highly and flexible automated distribution systems with quick responses.

Advantages Of Der:-
As compared to the traditional sources, the DER sources are more advantageous in terms of several features such as flexibility, cost etc. Various advantages of DER sources over traditional sources are given in below table (Table-1).

TABLE I. ADVANTAGES OF DER SOURCES OVER TRADITIONAL SOURCES

Sl. No.	Grid related terms	Traditional	DER
1	Overhead power lines	Long overhead power lines required	DER eliminates the need of overhead power lines.
2	Flexibility	Supply energy: no solution Existing method and don't allow what is best for them.	More choices
3	Cost of energy	Higher cost	Lower cost.
4	Grid reliability	It is less reliable.	DER reliable.
5	Power at remote location	It is unable to provide power at remote locations.	At remote location ready to provide power
6	Faster permitting of supply	Since they are installed far away, they facilitate supply slower due to long transmission lines.	Installation closer to load: facilitates faster supply.
7	Backup power	No backup.	If required provide backup

8	Environment friendly	Established method power generation based on non-renewable resources	DER is cleaner operation; it reduces emissions because of renewable resources.
9	Area required	Larger in size larger area occupied.	Since they are small so they require less area of infrastructure.
10.	Time of planning	More time required for planning.	Short time for planning

Characteristics Of Der Technologies:-

DER resources used numerous technologies to be established. These technologies are selected as the requirement of the uses/applications. Table-2 represents a comparison between different types of DER technologies in terms of advantages, limitations, fuel choice and size (kW).From this table the better type of DER technology can be easily estimated as per their need.

TABLE II. A COMPARISON BETWEEN DIFFERENT DER TECHNOLOGIES

Technology	Benefits	Drawbacks	Fuel Choice	Size (kW)
Micro-turbines ~28-33% Efficiency	1) Efficiency outstrips via thermal retrieval 2) Thermal yield -domestic and commercial application 3) Workable as peaking, base, back-up. 4) Commercially accessible in restricted amount.	Inadequate thermal yield for industrial applications	Propane, Natural gas, Diesel.	~15–250
Small Gas Combustion Turbines ~25-40% Efficiency	1)Highly Efficient outstrips via thermal retrieval 2) Technology commercially accessible - contender requirement on-site > 3 MW in the application related to DG. 3) Can Workable as peaking, base and back-up 4) numerous manufacturers 5) Installation cost- relatively low.	1) Sitting and permitting requirements- Potentially heavy 2) Environmental harms- releases of gases and noise. The Possibility of the requirement of fuel storage at on-site position	Methane, Natural gas, distillate	~3,000-15,000
Internal Combustion Engines ~28-37% Efficiency	1) Immensity power delivered when Utility out of stock 2) Quick start-up permits low sensitive procedures and provide the required power without UPSs (emergency lighting, elevators, HVAC, various production methods) 5) Can be efficient when united with thermal yield 3)Well established, stable technology	1) Insurance policy effect: Capital used when back-up generator is working 2) Low production cost usually favors utility source in all in limited occasion. 3) Environmental harms- discharging harmful gasses and sound pollution. 4) Requirement of fuel storage system at On-site locations.	Propane, Diesel, Natural gas, , Bio-gas, some petroleum products	<1–6,000
Fuel Cells ~45-55% Efficiency at	1) highly efficient outstrips via hydrogen 2) Base load can be operated	1) Limited commercially existing devices 2) Most studies are going on for the	Direct by hydrogen; natural gas, propane, methanol, or other hydrogen-rich source	MCFC (molten carbonate fuel cells):

high temperature ~30-40% Efficiency at Low temperature	successfully with the help of utility back-up 3) Viable domestic applications - a no-moving-parts energy devices 4) highly efficient coupled with thermal recovery 5) Green technology –The hydrogen fuels release only thermal and water in less amount as compared to the other fuels	automotive related applications 3) Fuel reformers are required for all applications (efficiency decreased fuel :electrical) 4) Few amount of harmful emissions are associated with this technology and its effect has changes according to the state 5) Cold start for MCFC: 1-2 days, PAFC: 3 hrs, PEMFC: 1 hrs, and SOFC: 2 minutes	through reformer	250–2,850 PAFC:200 PEMFC: 3-250 SOFC: 225-2,240
Photovoltaic	1) Fuel: No variable costs 2) No moving parts-low maintenance and good life 3) Noiseless, emission less 4) works for peak shaving 5) Reliable, grown-up technology	1) Large foot print (600 ft^2/kW) 2) Launching huge charges 3) Base load: not suitable 4) back-up: not suitable Only when complied with storage 5) output energy variable	None	Limited on the basis of the area availability
Large Wind Turbines	1) Fuel: Absence of variable costs 2) In utility implementation, In green power cost premium emissions are not allowed 3) Grown-up technology 4) Numerous producers	1) Siting requirements must be achieved 2) Irregular production due to uneven wind, which leads to intermittent energy output depends on the wind speed squared or cubed over the operational range. This makes it inappropriate as a backup or off-grid applications 3) Useful sources are highly needful for the purchases and sales of energy 4) The necessary requirement of the footprint up to 100ft^2/kW	None Required winds of ≥12 mph	<1-1,000

[Source: **Andersen, Reprinted from Public Utility ports, Inc., from the Summer 2001 issue of Fortnightly's Energy Customer Management.]**

Economics Of Der:-

Cost is one of the most important factors when considering any product or its installation. However, the cost estimation of a DER technology is highly complex, as it includes the equipment (or capital) cost and labour cost along

with other expenditures such as installing the equipment. The cost of generated electricity by the DER technology is also determined and compared with the current price of the existing power grid electricity. Table 3 gives a comparison of cost of various DER technologies

TABLE III. VARIOUS DER TECHNOLOGIES ALONG WITH THEIR COST

DER Equipment (Capital Price)		**DER Equipment (O&M Price)**	
DER Equipment	**Capital Cost (Rs./kW)**	**Time Until Maintenance Required (hours of operation)**	**Average Maintenance Costs (Rs./kWh)**
Microturbines	~49,000-77,000	5,000-8,000	~35–112 (estimated)
Combustion Turbines	~21,000-70,000	4,000-8,000	~28–35
Internal Combustion Engines	~21,000-56,000	750-1,000: change oil and oil filter 8,000: rebuild engine head 16,000: rebuild engine block	~49–105 (natural gas) ~35–70 (diesel)
Fuel Cells	~49,000-77,000	Yearly: fuel supply system Yearly: reformer system check 40,000: replace cell stack	~35–70 (estimated)
Photovoltaics	~3,15,000-4,20,000	Biyearly maintenance check	Starting investment/ year approx 1%
Wind Turbines	~56,000-2,45,000	Biyearly maintenance check	Starting investment/ year approx 1.5-2%

Issues And Challenges In Der:-

As the usability of the DER increases, the distribution grids have to itself bear the responsibility of the transmission systems. However, this entire system contains huge numbers of small generation units on the distribution grid, which leads to some technical challenges such as:

a) Interconnection or integration with grid -The microgrid provides a benchmark between island and interconnected grid [8, 9]. Installing micro grid in remote locations is expensive than in normal location as remote location such as island and hilly areas which are far away from utility where transmission lines are unable to reach. At the starting independently a micro grid in island (working separately from the grid), the current producing by the system having highly fluctuations, which causes significant deviations in system parameters such as voltage and frequency, and necessitate the protection of the generator for to be tripped offline during start-up [10],

b) Fixing of tariff- Traditional generation sources tariff is fixed in a particular way considering the initial cost as well as running cost. Individual micro grid installed at different locations would reduce the consumption of energy from the traditional grid which leads to loss for them. Hence a different tariff needs to be found out to balance the traditional grid and DER.

(c)The flow imposed by DER in between independent entities is bi-directional; this cannot be handled by today's existing distribution systems. Some modifications in the existing grid need to be done to accommodate the DER sources. With the increasing need of energy, a micro grid (DER) should be able to fulfill local increased load and robust communication between management system and individual source of energy.

(d) Protection-It is essential to redesign the system in order to familiarize the associated distributed generators with the distribution system. This will enhance the necessity of the distributed intelligence systems and its deeply relying on multi–party communications [3]. Hence one of the most significant threats on DER system is its safety [11].

(e) Balancing and stability of grid-The fundamental problem is that system becomes more complex and fails to control. Since there are number of microgrids or aggregated power sources in a system, it is very complex to handle the control among all the power sources. A solution to overcome this complexity is required. The DER system need to respond to all acute events separately using local information i.e. voltage, frequency and current [4] and hence should provide balance and stability of grid.

Applications Of Der:-

The DER users have diverse power requirements. Hospitals required great consistency (back-up power) and power quality (premium power) for the protection of the highly sensitive equipment. Industrial plants normally have huge energy bills, long manufacturing hours, and thermal procedures, and would hence pursue for such a DER applications that include inexpensive energy and combined heat and power. The power need of computer data centers is highly stable, high-quality, continuous (premium power). The existing and being developed in near future, DER technologies are dedicated to fulfill the specific demands of the individuals. Some of the current running DER plans are as:

1. A police station in New York's Central Park saves $200,000 over the cost of a line upgrade by using a fuel cell, which is used to run its electronic crime-fighting equipment.
2. The Santa Rita Jail in Dublin, California has established an on-site photovoltaic system and produces 1.18 megawatts. This project has predicted to contribute $15 million as net savings over the 25–year life of the project.
3. A natural gas distribution company installed a natural gas powered microturbine and make it jointly work/generation of the power with the plant's liquefaction section for supplying heat in the winter and cooling in the summer to serve over 240 communities in Minnesota [5].

Conclusions:-

An alternate distributing system DER is better over existing distributing system. Using concept of micro grids (DER) makes the system more reliable, more efficient, reduces transmission losses and lowers the cost of energy. Using DERs, we generate electricity from renewable resources, blackout chances get reduced and energy will also reach in remote locations to isolated communities. It is well known that various renewable energy provisions like solar and wind have been used in smart grids. But due to low capacity and size of renewable energy, it cannot be used complete energy pride by consumers. Therefore we need to develop control and common algorithm to emphasize efficient and reliable development. However, challenges exist like integrating with existing grid, complexity of micro grids, and installation cost of micro grids can be removed with the future research. So, developments in DER concept need more efforts to resolve the challenges.

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