Effects of Economic scheduling of DER with Renewables Energy

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Abstract: Now a day's improved demands in the country's electricity and occurrences of electricity scarcities, power quality (PQ) issues, rolling power failure, and electricity cost increase have affected several function consumers to seek additional sources of high-quality, reliable electricity. DER, small-scale power generation sources situated close to where electricity is used, deliver an substitute to or an improvement of the outdated electric power grid.DER is a faster, less costly option to the structure of large, central power plants and high-voltage transmission lines. DER offers the consumers that the potential for lower cost, advanced service reliability, high PQ, improved energy efficiency, and energy independence. Renewable distributed energy generation technology and green power like wind, PV, Geothermal, biomass or hydroelectric power has provided environmental benefits. Over the last two decades, public policies aimed at reducing carbon emissions to mitigate climate change have significantly altered the mix of generation technologies in many parts of the world. Because wind and solar generation now contribute a substantial fraction of the overall production of electrical energy, electricity markets have had to adapt to their intermittent and stochastic nature. To deal more efficiently with the larger imbalances between generation and load that renewable generation causes, markets operate on a much shorter time frame than before. Another adaptation is the increasing reliance on flexibility from the demand side to help maintain this balance. Marshaling demand side resources is challenging because they tend to be small and distributed throughout the system. Direct participation in the wholesale electricity markets by distributed energy resources (such as demand response, small scale energy storage, and photovoltaic generation) is not possible because it would vastly increase the number of market participants and render these markets unmanageable. In addition, the rules of the wholesale markets are complex and the requirements for participants are strict, making the transaction cost prohibitively expensive for small participants. To overcome this problem, new entities called aggregators are emerging. Their role is to serve as a commercial and technical intermediary between the wholesale markets and the owners of DER who could contribute to economic efficiency of the overall structure.

Keywords: - Renewable Energy Sources (RES), Photovoltaic (PV), Distributed Generation (DG), Distribution System (DS), Distributed Energy Resources (DER)

1. A Speculative Introduction

DG, is also called as distributed energy generation, on-site generationor area/decentralized energy is power generation and storage performed by a variety of small, grid coupleddevices referred to as DER. DERcontains of small-scale energy generation and energy storage units located at or near the load site. The key defining characteristics of DG technologies include the size of the power production of the technology and the location and application of the device. DGsystems are generally located close to the power demand, on the customer side of the meteror on the distribution network, rather than on the transmission network. The systems mostlyproduce between 1kW and 5MW of power supply. Some systems include:stand-alone rural or remote applications (for example where there are grid access constraints);grid-connected devices for the purpose of exporting electricity to the grid; utility-owneddevices (for the purposes of improving power quality and reducing power losses in certainareas); and combined heat and power (CHP) devices. Examples of DERs include rooftop solar PV units, natural gas turbines, micro turbines, wind turbines, biomass generators, fuel cells, tri-generation units, battery storage, electric vehicles (EV) and EV chargers, and demand response applications. These separate elements work together to form distributed generation.

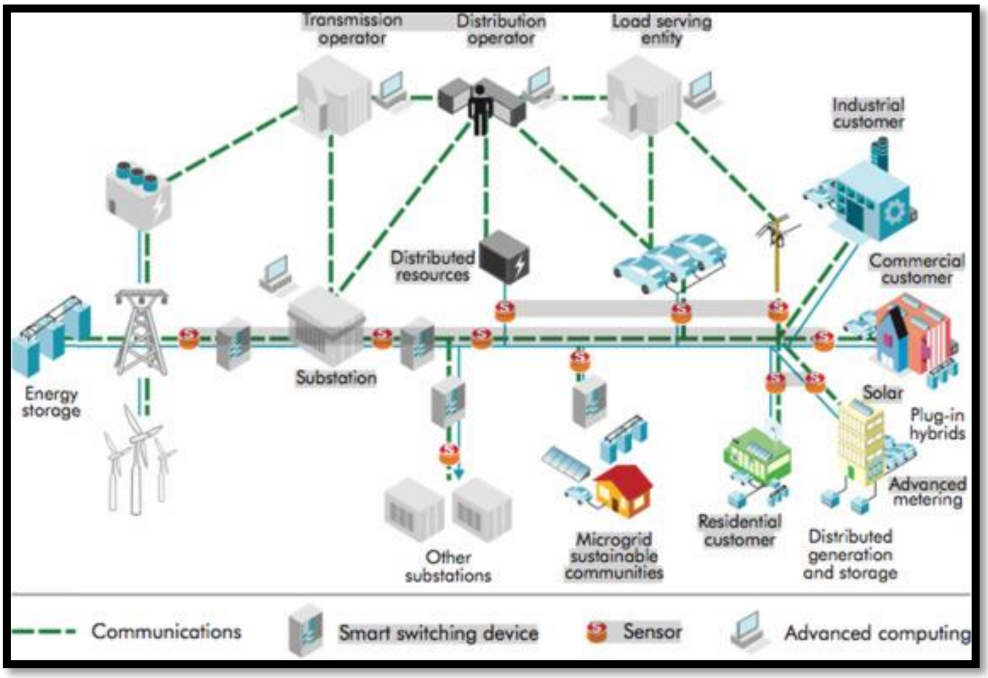

Fig 1: Distributed Generation

2. Characteristics of Distributed Energy System

1. **Comprehensive and efficient energy use-** With small size and high flexibility, a distributed energy system can satisfy the load demand and also solve the difficulty of long-distance transmission of cooling or heating sources. The efficiency of distributed energy can reach above 80%without transmission loss.
2. **An improvement to grid security and stability-** Deploying a distributed energy system on the user side as asupplement to the macrogrid can significantly enhancereliability and continuity of power supply to critical loads inthe event of grid collapse or disasters such as an earthquake,snowstorm, sabotage, or war.
3. **Small capacity, small area, low initial investment**- no longdistance transmission loss and investment on transmission and distribution (T&D) network, and Ability to meet special demands. This obviates the need for long-distance transmission and distribution and causing no feeder loss, requiring no investment on T&D network, and contributing to good economy and flexible, energy-efficient, and comprehensive services for end users.
4. **(iv)Environmental friendliness, diversified energy mix-** a new way to utilize renewable energy. Using clean fuels as the energy source, a distributed energy system is environmentally friendly. They have smaller capacity and is suitable for integration of renewable energy. In general DG has many advantages, however at same time it has difficulty in control system and random fluctuation behavior in nature. Thus a higher penetration of DGs may jeopardize grid stability. A microgrid controls DG, ES, and loads coordinately with the control system to form a single controllable power source and is directly arranged on the user side. Microgrid is a controllable entity for the grid; and for the user side, it can meet its unique demands, reduce feeder loss, and ensure local voltage stability.

3. Technology Used FOR DG

The variety of end-use is to be related to an even greater variety in technologies. The range of technologies used for distributed generation and described by the International Energy Agency includes, reciprocating Engines, renewable sources, gas turbines and micro-turbine.

Table 1: Technologies for distributed generation

Technology	Typical available size per module
Combined cycle gas T.	35–400 MW
Internal combustion engines	5 kW–10 MW
Combustion turbine	1–250 MW
Micro-Turbines	35 kW–1 MW
Renewable	
Small hydro	1–100 MW
Micro hydro	25 kW–1 MW
Wind turbine	200 Watt–3 MW
Photovoltaic arrays	20 Watt–100 kW
Solar thermal, central receiver	1–10 MW
Solar thermal, Lutz system	10–80 MW
Biomass, e.g. based on gasification	100 kW–20 MW
Fuel cells, phosacid	200 kW–2 MW
Fuel cells, molten carbonate	250 kW–2 MW
Fuel cells, proton exchange	1 kW–250 kW
Fuel cells, solid oxide	250 kW–5 MW
Geothermal	5–100 MW
Ocean energy	100 kW–1 MW
Stirling engine	2–10 kW
Battery storage	500 kW–5 MW

4. Economics Of Distributed Generation

Decentralization of the electricity system is recognized as one means of achieving efficient and renewable energy provision, as well as addressing concerns over ageing electricity infrastructure and capacity constraints. We find that there exists a large volume of research considering the financial viability of individual distributed generation technologies. However, there are few studies that focus on the pure economics of individual or groups of distributed energy generators, and even fewer still based on the economy-wide aspects of distributed generation. A distributed generation system may use renewable or non-renewable source of generation and can be grid connected or stand alone system. Due to low investment cost and small size Distributed Generation plays an important role in power system planning. The introduction of DG to distribution system can significantly impact the flow of power and voltage conditions at customers and utility equipment. These impacts may be either positive or negative depending on the distribution system operating characteristics and the DG characteristics. Positive impacts are generally called "system support benefits," and include :-

- Loss reduction
- Improved utility system reliability
- Voltage support and improved power quality
- Transmission and distribution capacity release
- Deferments of new or upgraded transmission and distribution infrastructure.
- Easy and quicker installation on account of prefabricated standardized components.
- Lowering of cost by avoiding long distance high voltage transmission.
- Environment friendly where renewable sources are used.

5. Policies To Encourage Distributed Generation

Distribution systems although are the most visible part of power system and largest investment, maintenance and operation expense are pointed to these section, but they had not received the technological impact in same manner as the generation & transmission systems. Installation and operation of DG units is one of the regulators' politics in recent years to reduce system losses and improve system efficiency. Government had developed some facilities to support investors to establish DG units as one of the most important loss reduction and peak saving programs to improve system efficiency and reduce peak load. So, there is a growing trend in world among buildings owners to install and operate distributed generation stations especially Combined Heat & Power (CHP) units due to facilities government had been assigned to commercial buildings. Distribution system operators are pleased to know the financial worth of loss occurs in their networks, they need to know the distribution network loss cost to evaluate improvement projects economic feasibility, setting priority of networks in implementing improvement projects and to know the financial flow of energy in their network. So annual energy loss and cost are the most important technical and economic issues in distribution networks operation respectively.

(i) DG Impacts on Distribution Systems- At first some useful definition which has been applied to this chapter is mentioned as follow:

(a) DG installed capacity- The total maximum output of each DG unit. The DG installed capacity in the network is the sum of the individual DG installed capacities.

(b) Capacity factor- The ratio of the energy produced, during the period of time considered, to the energy that could have been produced if DG would have operated at continuous full power during the same time period.

(c)DG penetration level- The ratio of the amount of DG energy injected into the network to the feeder capacity. Distributed Energy Resources (DER) had changed many aspects of distribution system operation, design and implementation. By increasing more decentralized systems with smaller generating units connecting directly to the distribution networks near demand consumption and consider distribution companies to reduce loss in their networks and benefit its results finding optimum point of cost of supplying loss in power distribution networks. To analyze the impact of DG on losses one single DG plant (a CHP unit) was located in several nodes along the feeder.

6. Recent Scenario Of Dg In Renewable Energy

The electrical sector in India is going to be modified for the enhancement of power quality, efficiency and consistent performance of generated power. To fulfill increasing load demand with low carbon emission (eco-friendly), our government focuses on the extracting maximum power from Renewable energy sources.

Performance of Renewable (R) and Non-renewable (NR) DGs have been reviewed in Table-2. Installed capacity of Renewable energy sources in India has been compared between 2010 and 2020 as stated in bar graph.

Table 2: Examples of Low Carbon Distributed Energy Generation Technologies

Distributed Heat Technologies	
Technology	**Description**
Solar water heating	Uses the heat of the sun to produce hot water
Heat pumps	Uses the warmth stored in the ground or air, via a cycle similar to that used in refrigerators, to heat water for space heating
Biomass	Small-scale biomass installations from approx.10kWto 2MW that provide space and water heating bycombustion of wood, energy crops or waste
Distributed Electricity Generation technologies	
Technology	**Description**
Solar Photovoltaic (PV)	Panels, often roof-mounted, that generate electricityfrom daylight
Wind	Large wind turbines that convert wind energy directly to electricity
Micro-wind (<100kW)	Small wind turbines that generate electricity - can nowbe roof-mounted as well as attached to tall masts
Micro-hydro	Devices that capture the power of flowing water andconvert it to electricity
Biomass/waste	Bi Installations range from landfill gas generation tolarge power-only facilities approaching 40MW
Combined Heat & Power Technologies	
Technology	**Description**
Biomass/waste	Installations range from 100kW biomass CHP to around 85MWth/20MWe
Micro-CHP and CHP up to 1MW	Small devices, usually gas-fired, that produce electricity and capture the waste heat produced as a by-product. CHP used on this scale tends to be for heat and power for a single house or on a communityor commercial scale (e.g. a housing estate or officeblock)
CHP from 1MWe-10MWe	CHP on this scale tends to be large community projects or small industrial applications
CHP over 10MWe	CHP on this scale tends to be large gas turbine industrial applications that require a substantial heat load on a continuous basis

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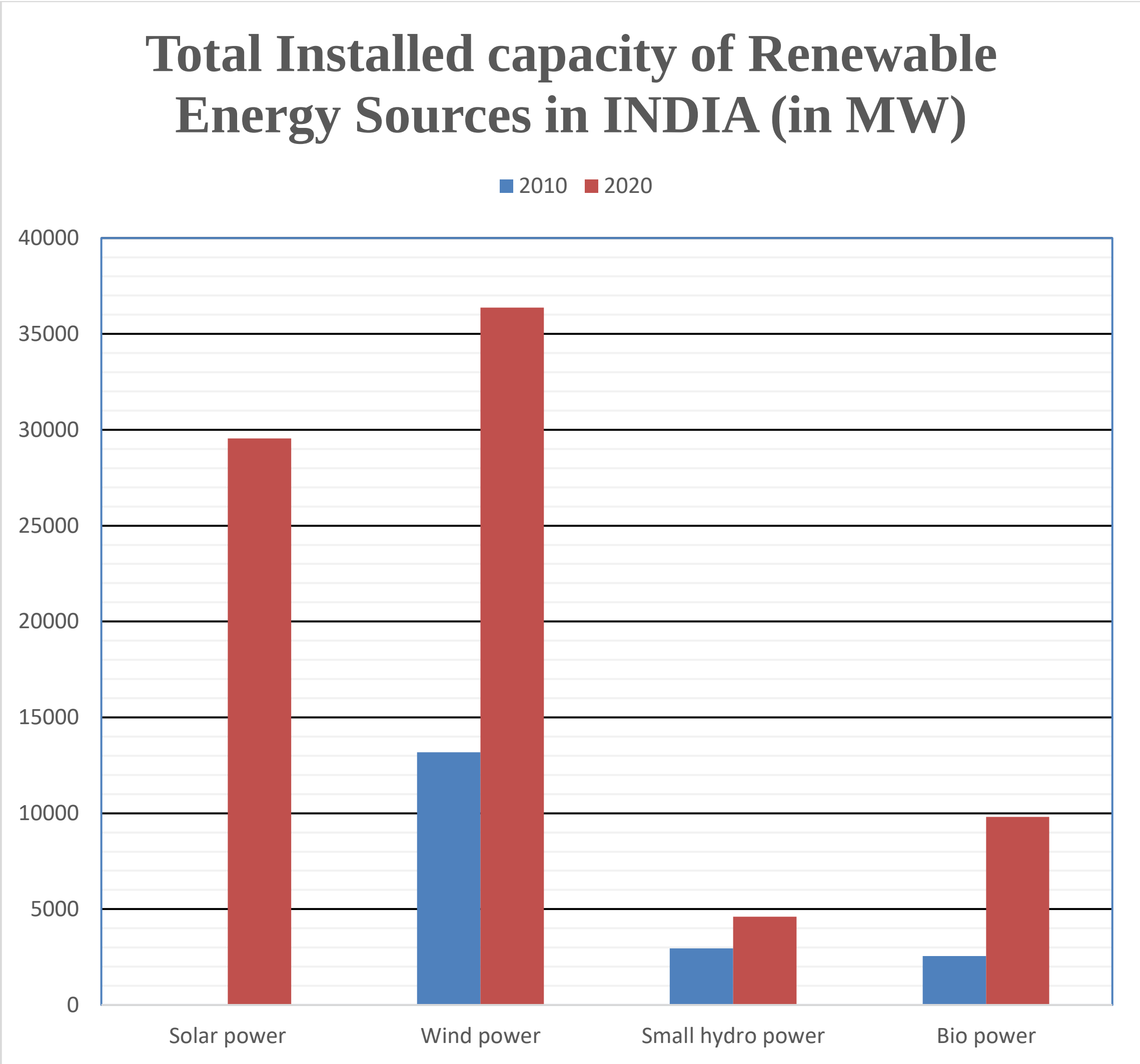

Fig 2: Bar graph showing the comparison between 2010 & 2020 in terms of installed power capacity (MW) of renewable energy sources in India

7. Conclusion

Renewable energy sources are emerging as necessary elements for building block of our Power Industry and Distributed generation. Its growth of installation and generation are rising exponentially in India as shown in bar graph of Fig.2. Its implementation is for the achievement of

(i) Eco-friendly environment
(ii) Enhanced power quality
(iii) Maximum power
(iv) Reliability in power supply
(v) Security
(vi) Cost effective in terms of generation, transmission and distribution.

Instead of so many positive impacts of DG based on RES, it has negative impacts too. It generates issues and challenges after interconnection with the power grid which are as follows:-

(i) Harmonic injection
(ii) SteadyState overvoltage
(iii) Voltage unbalance
(iv) Islanding

(v) Reverse power flow and many others.

Innovative mitigation techniques and protective measures are being applied to short out these issues as stated above to provide good quality of power supply to the consumers. Pure finances of entity or groups of distributed energy generators has become highlighted topic for today's power industry. Three ecological and communal impact of DG Penetration have been recognized and assessed to analyze their consequence. Deregulatory electricity market is one of outcome of unbundling of generation, transmission and distribution of electricity facility. It has become easy to access available information regarding network for all market participants due to adoption of ISO in deregulated electricity market. ISO has created chances to purchases contracts which barricade the threat due to variation of electricity prices.

References

[1] "Renewable energy in India", https://en.wikipedia.org/wiki/Renewable_energy_in_India.

[2] E. Vilchez, J. Stenzel, "Impact of Renewable energy Generation technologies on The Power Quality of the Electrical Power Systems", 22nd International Conference on Electricity Distribution, pp.1- 4, 2013.

[3] P. Lezhnyuk and O. Buslavets, "Impact of Renewable Sources of Energy on the Level of Active Power Losses in Distribution Networks", 2nd International Conference on Intelligent Energy and Power Systems (IEPS), 2016.

[4] A.A. BayodRújula, J. Mur Amada, J.L. Bernal-Agustín, J.M. Yusta Loyo, J.A, Domínguez Navarro, "Definitions for Distributed Generation: a revision", RE&PQJ, Vol. 1, No.3, March 2005.

[5] "EIA: natural gas-fired reciprocating engines are being deployed more to balance renewables", https://www.greencarcongress.com/2019/02/20190220-eia.html.

[6] "Combined Heat and Power Technology Fact Sheet Series", Energy Efficiency & Renewable Energy, U.S. department of Energy.

[7] Chitrarth Lav, Raj Kumar Singh,Chaitanya Kaul, Anurag Rai, "Potential of Micro Turbines for Small Scale Power Generation", International Journal of Advanced Information Science and Technology (IJAIST), Vol.13, No.13, May 2013.

[8] SN Singh, Jacob Østergaard and Naveen Jain "Distributed Generation in Power Systems: An Overview and Key Issues", Proceedings of IEC, 31 May 2014.

[9] Xinhong Huang, Zhihao Zhang, Jin Jiang, "Fuel Cell Technology for Distributed Generation: An Overview", IEEE ISIE, Montreal, Quebec, Canada, July 9-12, 2006.

[10] "Ocean energy", https://mnre.gov.in/ocean-energy.

[11] Sumanth Yamujala, Mehtab Fatima, Indrakanti Abhinay Sri Teja, Yalavarthi Lahari, "Present Scenario of Distributed Generation in India – Technologies, Cost Analysis & Power Quality Issues", International Conference on Innovative Applications of Computational Intelligence on Power, Energy and Controls with their Impact on Humanity (CIPECH14), 28 & 29 November 2014.

[12] "Annual Report", https://mnre.gov.in/file-manager/annual-report/2010-2011/EN/Chapter1/chapter1_1.htm.

[13] Roger C. Dugan / Mark F. McGranaghan / Surya Santoso / H. Wayne Beaty, "Electrical Power Systems Quality", Second Edition,McGraw-Hill, 2004.